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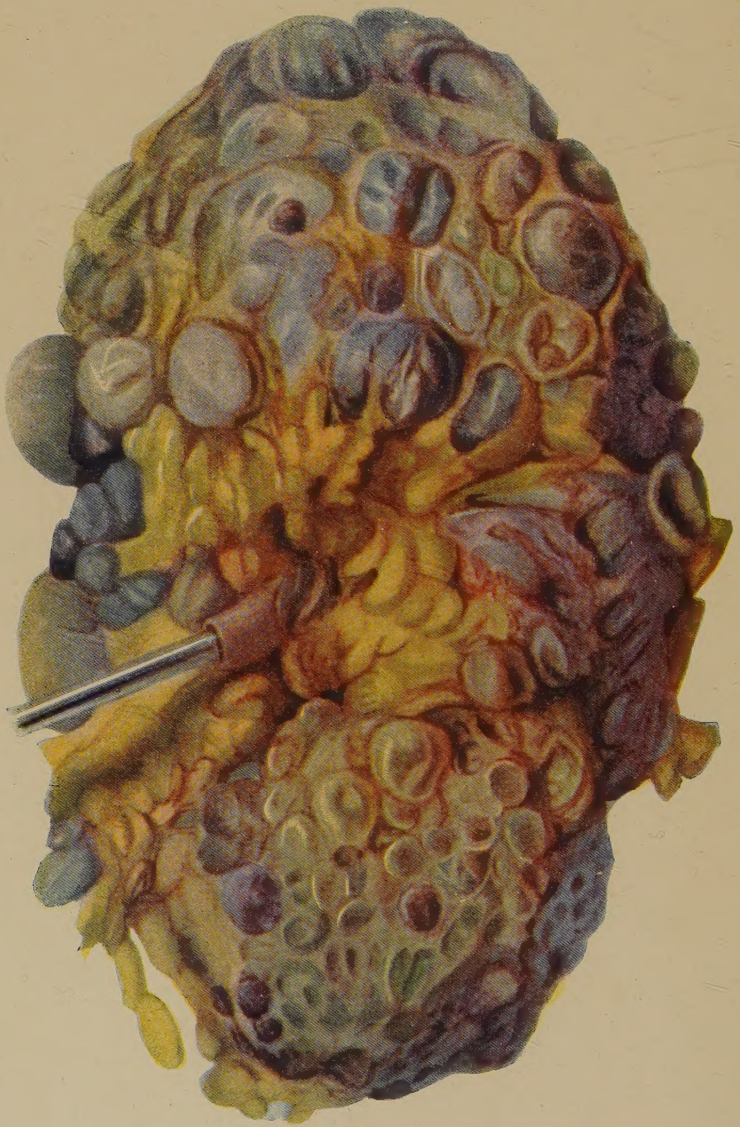

Polycystic Degeneration of the Kidney.
(Kummel and Rumpel.)

A SYSTEM OF

PRACTICAL SURGERY.

BY

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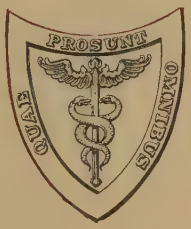
SURGERY OF THE PELVIS AND THE GENITO-URINARY ORGANS.



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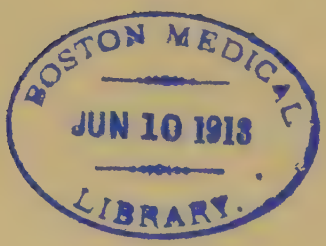

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CONTENTS.

MALFORMATIONS, INJURIES, AND DISEASES OF THE PELVIS.

CHAPTER I.

PAGE

Congenital Malformations of the Pelvis 17

CHAPTER II.

Injuries of the Pelvis 23

CHAPTER III.

Diseases of the Pelvis 45

CHAPTER IV.

Pelvic Operations 73

MALFORMATIONS, INJURIES, AND DISEASES OF THE ANUS AND RECTUM.

CHAPTER V.

Anatomy of the Rectum—Methods of Examination of the Rectum . . 77

CHAPTER VI.

Congenital Malformations of the Anus and Rectum 83

CHAPTER VII.

Injuries of the Rectum 92

CHAPTER VIII.

Diseases of the Anus and Rectum 97

ABNORMALITIES, INJURIES, AND DISEASES OF THE KIDNEY AND URETER.

CHAPTER IX.

PAGE

Examination of the Kidney and Ureter 175

CHAPTER X.

Congenital Abnormalities of the Kidney and Ureter 218

CHAPTER XI.

Injuries of the Kidney 229

CHAPTER XII.

Diseases of the Kidney 245

CHAPTER XIII.

Retention-tumors of the Kidney: Uronephrosis, Pyonephrosis, and Abscess 258

CHAPTER XIV.

Calculus of the Kidney: Nephrolithiasis 293

CHAPTER XV.

Chronic Inflammations of the Kidney 316

CHAPTER XVI.

Tumors of the Kidney and of its Pelvis 349

CHAPTER XVII.

Injuries of the Ureter 375

CHAPTER XVIII.

Diseases of the Ureter 389

CHAPTER XIX.

Operations on the Kidney and Ureter 393

CHAPTER XX.

The Suprarenal Gland 416

ABNORMALITIES, INJURIES, AND DISEASES OF THE BLADDER AND PROSTATE.

CHAPTER XXI.

PAGE

PHYSICAL EXAMINATION OF THE BLADDER 419

CHAPTER XXII.

CONGENITAL ABNORMALITIES OF THE BLADDER 428

CHAPTER XXIII.

INJURIES OF THE BLADDER 447

CHAPTER XXIV.

DISEASES OF THE BLADDER 464

CHAPTER XXV.

INJURIES AND DISEASES OF THE PROSTATE GLAND 539

MALFORMATIONS, INJURIES, AND DISEASES OF THE URETHRA.

CHAPTER XXVI.

THE EXAMINATION OF THE URETHRA 565

CHAPTER XXVII.

CONGENITAL MALFORMATIONS OF THE URETHRA 569

CHAPTER XXVIII.

URETHRAL INJURIES AND THEIR SEQUELÆ 589

CHAPTER XXIX.

DISEASES OF THE URETHRA EXCLUSIVE OF VENEREAL DISEASES 621

MALFORMATIONS, INJURIES, AND DISEASES OF THE PENIS.

CHAPTER XXX.

CONGENITAL ANOMALIES OF THE PENIS 625

CHAPTER XXXI.

INJURIES OF THE PENIS 631

CHAPTER XXXII.

DISEASES OF THE PENIS, EXCLUSIVE OF VENEREAL DISEASES 637

ANOMALIES, INJURIES, AND DISEASES OF THE SCROTUM, TESTICLE, VAS DEFERENS, AND SEMINAL VESICLE.

CHAPTER XXXIII.

PAGE

CONGENITAL ANOMALIES OF THE SCROTUM AND TESTICLE 653

CHAPTER XXXIV.

INJURIES AND DISEASES OF THE SCROTUM 660

CHAPTER XXXV.

DISEASES OF THE COVERINGS OF THE TESTICLE AND OF THE SPERMATIC CORD . 668

CHAPTER XXXVI.

INJURIES AND DISEASES OF THE TESTICLE 693

CHAPTER XXXVII.

DISEASES OF THE SEMINAL VESICLES 718

MALFORMATIONS, INJURIES, AND DISEASES OF THE PELVIS.

By Prof. Dr. STEINTHAL.

CHAPTER I.

CONGENITAL MALFORMATIONS OF THE PELVIS.

CONGENITAL TUMORS OF THE SACRUM.

The congenital malformations due to faulty closure of the vertebral arches have already been considered in Vol. II. These were myelocystocele and the various forms of meningocele. They occur chiefly in the lumbar and sacral portions of the spine, although they may appear elsewhere. A second variety of cyst occurs exclusively in the sacral region, and owes its origin to a hernia-like bulging of the dura. At the junction of the sacrum and coccyx the fibrous tissue is cleft and the dura bulges between the cornu of the sacrum and coccyx and forms a cystic tumor beneath the skin. This sort of meningocele appears through a normal opening in the bone, and not through a pathological cleft, and is best called sacrococcygeal meningocele, whereas the other variety is best termed sacrolumbar meningocele. Both varieties of meningocele are frequently surrounded by other sorts of tissue. Bergmann has called attention to the fact that sacrolumbar meningocele is frequently associated with lipomatous, cavernous, or cystic masses; in the latter case with large lymphangiomata. Lymphangiomata and tumors consisting of a great variety of tissue, the teratomata, are found in connection with sacrococcygeal meningocele, but never with lipoma. These cystocavernous lymphangiomata and teratomata are more common, to be sure, without any sacrococcygeal meningocele, and form a subdivision of the congenital tumors of the region of the coccyx in connection with the lipomata. Bergmann subdivided teratomata into: 1, simple dermoids—*i. e.*, sacs containing gruel-like material; 2, compound dermoids—*i. e.*, such that contain besides the elements of the skin, bone, cartilage, teeth, glandular substances, brain- and nerve-substance; 3, sarcomata, especially cystosarcomata, that are apt to be mixed; and, 4, subcutaneous parasites or fœtal implantation-cysts.

Middleldorpf first called attention to the canalis postanalis as the seat of origin of teratoma in this region. In a small congenital lipoma

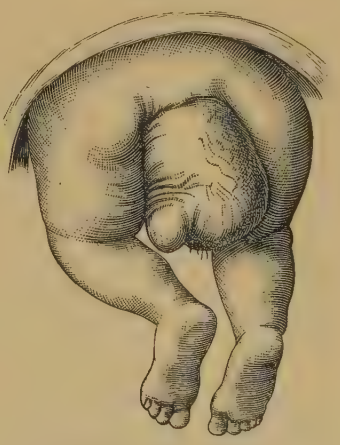
of the coccygeal region he found a diminutive convoluted loop of intestine that communicated externally. This developmental explanation has been applied by Hildebrand to the epithelial cysts found in front of the coccyx, and by Ritschl to very complicated congenital tumors found also in this region. Tourneux and Hermann claim that the tumors found on the posterior surface of the coccyx, especially those containing nerve-tissue, develop from remnants of the embryological cord.

There is some dispute whether these compound tumors are not due to other conditions at times, such as a second ovum, for instance. Borst claims that implantation of such an ovum applies only

Fig. 1.

Sacral meningocele. (Muscatello.)

Fig. 2.



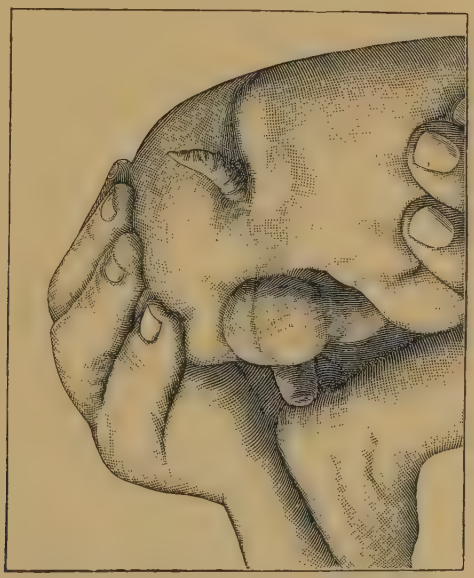
Congenital cystic tumor of the sacrococcygeal region. (Ricard and Lannay.)

to a limited number of the cases, and that for the majority incomplete obliteration of the canalis neurentericus and canalis postanalis explains the condition. Stolper believes that all parasitary cystic mixed tumors are due to double ovum. Kiderlen recently opposed this theory, and the author believes with him that the monogerminal explanation is quite sufficient for the majority of cases if it is assumed that the displacement of nuclei leading to the development of tumors took place before development of the three primary layers.

Congenital tumors of the sacrum have certain points in common in spite of their great differences and manifold clinical signs. They

never extend beyond the posterior upper margin of the gluteal muscles, but develop toward the pelvis and between the legs of the child, displace the genitals, and especially the anus, downward and forward. They occupy certain positions according to their structure. Lymphangiomata and teratomata surrounding the meningocele are found on the dorsal surface of the coccyx, whereas congenital lipomata, teratomata, and cystic lymphangiomata are found in front of the coccyx. These are very liable to be found high up between the coccyx and the rectum, and never connect with the dura. Kroner and Marchand, however, have described a case of anterior sacral meningocele in a girl twenty years of age that resembled a cyst of the broad ligament. This tumor was first aspirated, then opened and drained; death followed with symptoms indicating meningitis.

FIG. 3.



Caudal appendage in a child. (Hagenbach.)

There remain to be mentioned certain other tumors which Virchow has called the caudal growths in man. He distinguishes: 1, complete tails, where there is an actual increase in the number of coccygeal vertebræ; 2, imperfect—tails that do not contain bone, but are undoubtedly connected with the vertebral column by rudimentary tissue; 3, tail-like dermal appendices, due to inflammatory processes between the membranes of the ovum and the surface of the embryo.

Finally attention is directed to the peculiar condition where a circumscribed region over the sacrum is thickly covered with hair. This region is immediately over a cleft in the sacral canal (spina bifida occulta with sacrolumbar hypertrichosis). These patients as they come

under observation are fully developed, and have no other signs nor are these disturbances in the nervous system, such as paralysis of the legs, bladder, etc. The details of this condition have already been referred to.

The above-mentioned tumors may be classified as follows:

I. Sacrolumbar tumors:
   1. Pure myeloceles and meningoceles (spina bifida).
   2. Myeloceles and meningoceles (spina bifida) associated with: *a*, lipoma; *b*, cavernous tumors; *c*, cystic lymphangioma.
   3. Pure lipomata and lymphangiomata.

Fig. 4.

Skiagram of a simple form of meningocele. (Carl Beck.)

II. Sacrococcygeal tumors:
   A. Tumors of the dorsum of the coccyx and sacrum.
      1. Pure meningoceles of the hiatus canalis sacralis.
      2. Meningoceles associated with: *a*, lymphangiomata; *b*, teratomata.
   B. Tumors on the anterior surface of the sacrum and coccyx: *a*, lipoma; *b*, lymphangioma; *c*, teratoma.

III. True and false tails.

IV. Sacrolumbar hypertrichosis and spina bifida occulta.

Diagnosis.—Spina bifida may not be detected when there is no meningocele, or when this is surrounded by a solid tumor in such a

way that the meningocele is pressed in and found only on operation. Sacrolumbar hypertrichosis should always arouse suspicion of spina bifida occulta. Myelocystocele is difficult to distinguish from meningocele. Both of these conditions may be covered by normal skin and subcutaneous tissue. Both may be situated in the median line and be connected with the cleft in the vertebræ by a broad peduncle. It may even be impossible for the surgeon to tell whether he has to deal with a myelocele, a meningocele, or a cystic lymphangioma. (Bergmann.) If the tumor in question is not exactly in the median line, it is fair to presume that the tumor is a meningocele. The Röntgen ray will give

FIG. 5.

Skiagram of the same case after extirpation. (Carl Beck.)

a certain amount of information relative to the size of the cleft in the bone. (Beck.)

A fatty tumor situated beneath the upper margin of the gluteal muscles should never be mistaken for meningocele, nor should the tumors found in front of the coccyx. These tumors, especially the lymphangiomata on the dorsum of the coccyx, may lead to error in this direction.

Sänger mentions the following points that distinguish simple dermoid cysts in the pelvic connective tissue from ovarian cysts and similar growths. The dermoid cysts develop toward the pubes.

Their surface is smooth and sharply outlined. The uterus is pressed upward without spreading the broad ligaments, and two normal ovaries can usually be found. Besides this condition, echinococcus cysts and anterior sacral meningocele must be considered in the differential diagnosis; exploratory puncture will give the desired information in this direction.

Compound dermoids and cystosarcoma cannot always be sharply distinguished, which is the reason why Maas included these in one group. The former may at any time begin to increase rapidly in size. The subcutaneous growths—*i. e.*, those congenital tumors that contain distinct remnants of the head, spine, pelvis, and bones of the extremities—can only be detected by palpating the component parts.

Treatment.—The task of the surgeon is comparatively slight compared with the histological and developmental investigation. The greatest mortality is in cases of spina bifida, for these usually die within a short time, because with an increase in size the thin cutaneous covering is easily injured, becomes ruptured, and fatal meningitis results. Sometimes the accompanying hydrocephalus is the cause of death. Only the pure meningoceles with a thick covering live for a greater length of time, although even these may rupture spontaneously or as a result of some accidental injury. In very rare cases a sort of spontaneous cure takes place in spina bifida. The prognosis of the coccygeal tumors is doubtful only in compound dermoids and cystosarcomata, because these, especially the cystosarcomata, are apt to grow rapidly. When this does take place, they should be removed at once. Other tumors, however, should also be removed, so as to avoid, if possible, complications such as inflammation and suppuration. The operation in these tumors is similar to an operation upon tumors in other regions of the body. They should be shelled out if possible, although this may be extremely difficult in tumors situated along the anterior surface of the coccyx, where it is often impossible to reach the upper end of the tumor. A piece therefore may have to be left behind. In benign growths this may be done without fear of harmful consequences. The upper portion may be destroyed if possible with the cautery. Dermoid cysts in the pelvic connective tissue should be exposed by opening the ischiorectal fossa and dividing the levator ani and pelvic fascia. When operating upon sacral parasites, it should be observed whether there is any connection between the parasite and the vertebral canal of the autosite. (Kleinwächter.)

In hypertrichosis it is justifiable to expose the cord when certain signs of irritation indicate that this structure is being pressed upon. At times one may be as fortunate as Jones and Maas, and have recovery follow division of an offending band. The operation for spina bifida has been considered elsewhere.

CHAPTER II.

INJURIES OF THE PELVIS.

THE bones of the pelvis are quite elastic. This quality is increased by the ligaments and fibrous disks uniting the various sections. The pelvis is protected by powerful muscles, and the force necessary to produce fracture or dislocation is very great. In young people the soft parts surrounding the pelvis are frequently much injured, especially in the region of the pubes and in the gluteal region, without there being any real bony lesion. The force is broken by the soft parts and the elasticity of the bones.

Injuries of the pelvis in times of peace are not common. Golebiewski found only 1 fracture of the pelvis in 3972 injuries—*i. e.*, 0.025 per cent. There was 1 contusion of the pelvis and 3 other injuries. Of 9100 injuries tabulated elsewhere, 0.05 per cent.—*i. e.*, 5 cases—were fractures of the pelvis. Only 0.3 per cent. of all fractures affect the pelvis itself.

FRACTURE OF THE PELVIC BONES.

The force necessary to fracture these bones is very great as a rule, although Richter and Kaufmann have reported cases in which the amount of force was very slight. Rose reports the case of an old woman who suffered a fracture of the pelvis following a slight fall on the hip. This patient died of secondary purulent peritonitis. All the usual forces produce as a rule multiple fractures that are more or less typical, and it is therefore justifiable to speak of the mechanism of pelvic fractures. This subject has been gone into by Malgaigne, Rose, König, and others, and experiments have been made by Messerer and Kusmin.

The typical situations for a fracture of the anterior ring of the pelvis are the places where the bones are thinnest, and where these portions unite with the thicker parts, or where the various sections of the bone during youth are united by cartilage. They are therefore: *a*. At the tuberculum pubicum, the direction being toward the obturator foramen. *b*. At the iliopectineal eminence, the direction being toward the obturator foramen or into the acetabulum, the obturator foramen, and sometimes into the greater sciatic notch. *c*. In the region of the ascending ramus of the ischium. *d*. At the point of junction of the ramus of the ischium with the descending ramus of the pubes.

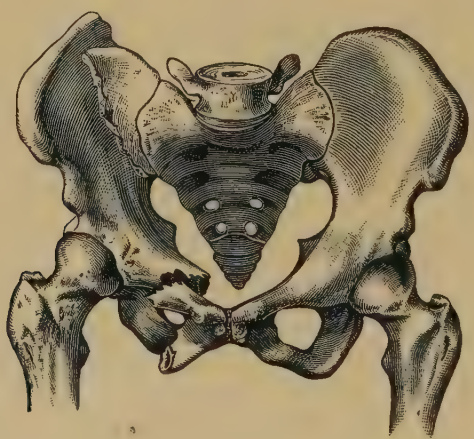
In the posterior portion of the pelvis—*i. e.*, in the portion behind

the acetabulum—fractures that pass vertically from the brim of the pelvis down to the greater sciatic notch through the ilium, or they may pass through the lateral masses of the sacrum. Sometimes the iliosacral joint itself becomes separated.

It does not seem to be a matter of indifference from which direction the force is applied.

a. When the force is applied in a sagittal direction to the pubes alone, this is usually broken out with the adjoining portion of the bone and displaced inward into the pelvis. The fractures take place as already described, and are frequently symmetrical. Sometimes only one side is broken and the other side is kinked, or the fracture is unilateral. It may even happen that only the ascending ramus of the pubes is injured.

FIG. 6.



Showing upward and backward displacement in a complete fracture of the ilium. (Hoffa.)

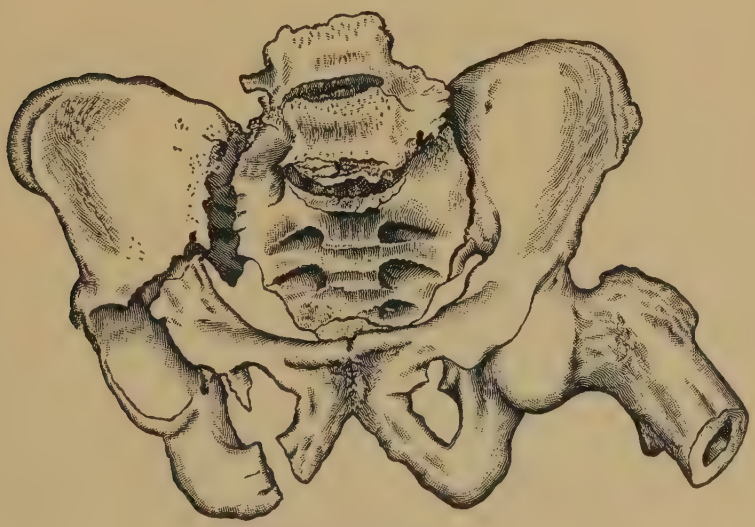
b. When the force is applied not only to the pubes itself, but also to the upper portion of the ilium, the flanges of the ilium are pressed outward and the ligaments in front of the sacroiliac joint are put under such tension that they either tear and the sacroiliac joint gaps, or, being stronger than the bone, the lateral portion of the sacrum breaks off through the sacral foramina. Besides these cases there are those described by König and Kloos in which the force is applied in a sagittal direction, and the anterior surface of the lateral portion of the sacrum is crushed, while the posterior part shows linear fractures. König believes that these fractures are produced by the ilium being driven into the sacrum in front, and by the posterior ligaments being put under such tension that they either tear or break off portions of the adjoining bones. Messerer and Kusmin were not able to produce these fractures by direct anteroposterior pressure.

c. When the power is applied in the frontal plane, the flanges of the ilia are approximated and the anterior portion of the pelvic arch

breaks in the usual way with separation of the sacroiliac joint or with fracture of the ilium vertically downward from the crest to the greater sciatic notch. This latter variety has been termed by Malgaigne a double vertical fracture, and is said by him to be due to a fall upon the hip. Messerer and Kusmin produced a fracture of this sort by compressing the pelvis laterally just above the socket.

Kusmin and most authors consider fractures of the anterior pelvic ring to be direct, whereas Katzenelson considers them to be indirect. According to Katzenelson, the pelvis consists of two semicircles, each consisting of an anterior and a posterior arm, with the region of the acetabulum as the summit. When the force is applied anteroposteriorly, the symphysis is pressed inward and the iliopectineal eminence and the tuberosity of the ischium are pressed outward. When the

FIG. 7.



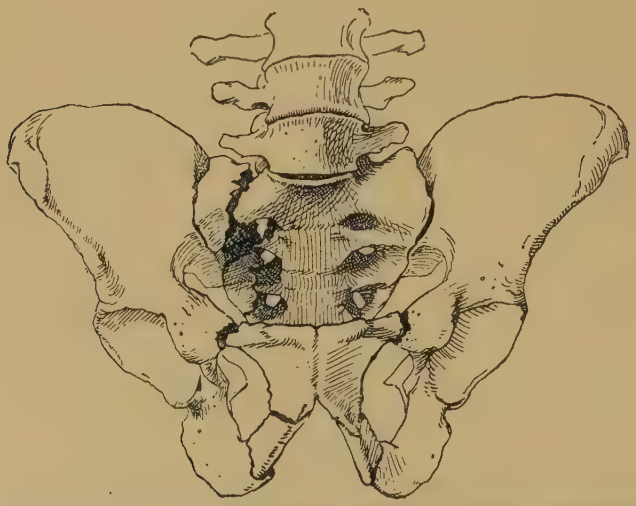
Malgaigne's fracture.

force is applied laterally, the iliopectineal eminence and the tuberosity of the ischium are pressed inward, whereas the symphysis is pressed outward. The fractures are supposed to take place because of too great flexion in the three above-mentioned typical regions. Malgaigne's vertical fractures through the ilium are also supposed to be due to indirect force. This author claims that the fact that most of these fractures, like all indirect fractures, are diagonal favors this theory.

No one will dispute the great value of experimentally produced fractures of the pelvis, although it is not always possible to make the experiments correspond to the pathological finding, because in many accident cases the direction of the power applied is not only unknown, but is also not always purely anteroposterior or lateral. Fig. 8 illus-

trates this point. The symmetrical breaks in the anterior region would seem to indicate an anteroposterior force, whereas the fracture in the right posterior portion would be in favor of a force acting in the frontal plane. Practically it is sufficient to remember that forces

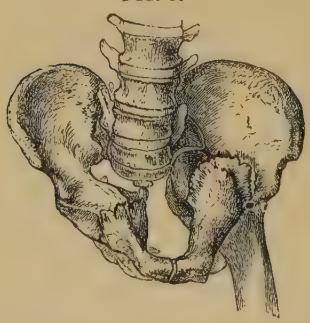
FIG. 8.



Symmetrical fracture of the anterior ring of the pelvis and right-sided fracture posteriorly. (Bruns.)

applied to the pelvis produce multiple more or less characteristic breaks in certain places, and are apt to separate the pubes *in toto* and displace it inward, while in the posterior portion of the pelvis the fractures resemble crushes or bony laceration. Malgaigne's so-called double vertical fracture is a special variety with one-half of the pelvis broken into three pieces. If the middle portion is movable, it is displaced upward with the leg, and the extremity on that side becomes considerably shortened. This middle portion may rotate round the vertical or horizontal axis and alter the shape of the pelvis in this way.

FIG. 9.



Fracture of the pelvis, showing head of the femur driven through the acetabulum. (Bryant.)

Fractures of the acetabulum deserve special mention on account of their relation to the leg. The author has already emphasized that in fractures in the region of the symphysis the break may involve the acetabulum. Isolated fractures of the acetabulum, however, have also been observed; for instance, after a fall on the great trochanter, which is liable to drive the head of the bone inward and split the acetabulum into

its three component parts. In some cases the head of the femur has been found driven through into the pelvis. The acetabulum may also be fractured by a fall on the tuberosity of the ischium. Hamilton distinguishes fractures of the brim of the acetabulum and fractures of the base of the acetabulum with or without displacement of the leg. Fractures of the brim of the acetabulum with displacement of the leg occur only in connection with dislocation of the hip, and will not be considered more in detail in this connection. The other fractures of the brim of the acetabulum are of little practical importance.

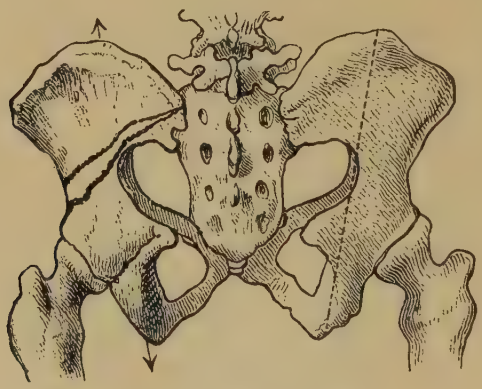
FIG. 10.

Elevation of lateral fragment.

There remain to be considered the isolated fractures of the pelvis, the most important of which are the rare fractures of the sacrum. They are produced by a fall or some other force acting from behind. The sacrum is usually broken off transversely below the sacroiliac synchondrosis and displaced inward into the pelvis. However, the sacrum may be broken into several pieces without marked displacement. Michaelis has reported a case of this sort. A single fracture of the flange of the ilium either passes close to the linea arcuata or the crest is split off. The shape and the direction of the fracture may vary greatly. Thiem has recently called attention to the practical

significance of transverse fractures of the ilium called Duverney's fractures. (Fig. 11.) The bony crushes in the upper posterior portion of the sacrum seem also to be of importance, and are associated with considerable destruction of the spongy portion. (Bähr.) The tuberosity of the ischium or the ischium itself may be broken off *in toto*. The line of fracture passes in front through the descending ramus of the pubes and backward behind the acetabulum. In the latter case the fragment is liable to be displaced downward by the flexors of the leg. Bartels and Leteneur mention an isolated fracture of the horizontal arm of the pubes. Wernher reports a case in which the descending ramus of the pubes was kinked inward, and Malgaigne has also reported isolated fractures of this bone. These latter fractures do not seem to be produced by any direct external force, but by some power acting from within the body. They evidently belong to the few scattered cases of fracture due to muscular

FIG. 11.



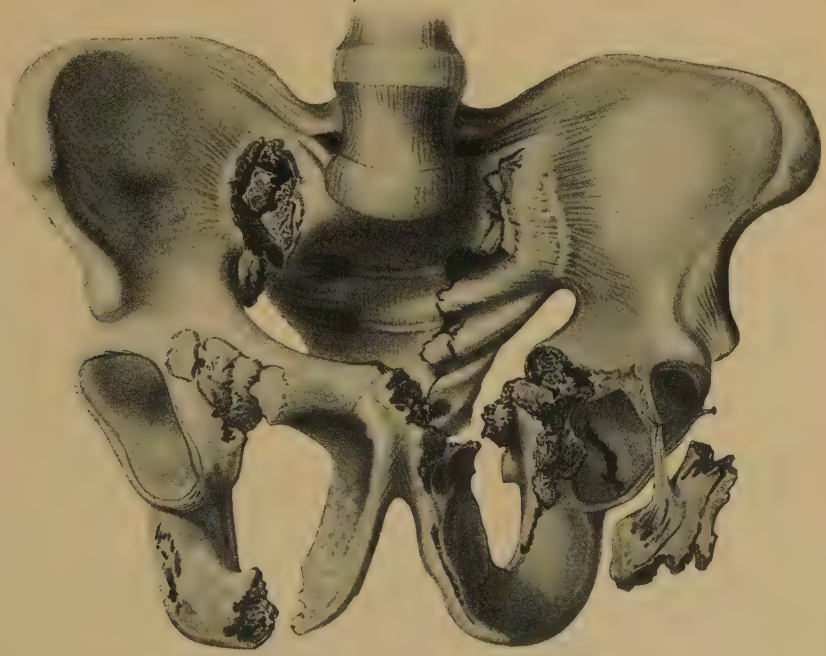
Duverney's fracture. (Thiem.)

action. Maydl reports a fracture of this sort involving the ascending ramus of the pubes, and Linhardt one involving the anterior inferior spine of the ilium, said to have been produced by traction upon the iliofemoral ligament. Katzenelson collected 2 other cases from the literature, and the author himself can report 1 case in which the right anterosuperior spine was pulled off. Certain fractures of the crest of the ilium, where the fragments consist of an anterior smaller and a posterior larger half, are considered by Riedinger to be fractures due to muscular action of the gluteus maximus and medius. The table of Michaelis shows the frequency to fracture in the various regions of the pelvis : pubes, 51 cases ; ischium, 20 cases ; ilium, 19 cases ; sacrum, 4 cases ; and acetabulum, 10 cases.

The forces applied usually involve a considerable area, so that it is uncommon to have open wounds. Even the most severe fractures of the pelvis are usually simple. Only when the bone becomes consider-

ably splintered does it happen that the skin is punctured. The damage to the pelvis itself is not the reason why these injuries are so very grave; it is chiefly the facts that the pelvic organs become involved, and that there are liable to be severe injuries in other portions of the body. The chief complications arise from the urinary apparatus, and with fractures of the pubes these complications are the most common because the bladder and urethra are unable to escape from the fragments and become torn or stretched.

FIG. 12.



Fracture of the pelvis. (Anger.)

The bladder may be injured by any force applied to the abdomen itself, especially if the organ is distended. (Bartels.) The reason for this is that a full bladder is more apt to burst than an empty one and is not protected by the symphysis. According to Bartels, it is characteristic of these primary ruptures that they are intraperitoneal. For this reason, when intraperitoneal rupture of the bladder is found in connection with fracture of the pelvis the condition may be considered the direct effect of the force applied. Bartels collected 149 cases of injury of the pelvis that were combined with rupture of the bladder; 31 of these were associated with fracture of the pubes and 22 with separation of the symphysis. The latter cases when not associated with fractures of the pubes appeared to be primary injuries of the bladder. Rupture of the bladder in fracture of the sacrum or of the acetabulum and with separation of the sacroiliac joint also belongs to this group. In fract-

ure of the pubes, however, the bladder may be torn secondarily by displaced pieces of bone or by splinters. The splinters may reach the interior of the bladder, and later form the nucleus of stones.

Injuries of the urethra are usually found in the membranous portion, and are almost always due to some injury of the anterior wall of the pelvis. They are most common in fractures of the descending ramus of the pubes and of the ascending ramus of the ischium, especially if the fracture is near the symphysis. These injuries are more common when the force applied is in the frontal plane, which explains how the urethra is more liable to be injured when the pelvis is pressed together from side to side. The pressure from side to side in itself is not the cause, but the position of the fracture produced, because the fragments of bone displaced from their usual position in the immediate vicinity of the urethra simply crush this structure. This explanation does not cover all of the cases, for rupture of the urethra may occur when the force is applied in the sagittal plane. Where a broad piece of the symphysis is separated, it is impossible that fragments of the bone could be jammed into the urethra. It must be remembered that the membranous portion of the urethra passes through the layers of the triangular ligament. When this structure is displaced inward with the fragment, the urethra simply tears off. The rupture is usually complete, and there is not apt to be any injury of the skin. The force applied is from above downward and is not liable to injure the perineum. The conditions are different when a force is applied from below upward upon the perineum, as in a fall with the legs apart. It is very uncommon to have a simple crush of the urethra or to have it become kinked.

Compared with these injuries of the urinary apparatus, those of the remaining structures in the pelvis are very insignificant. The rectum and vagina may be injured, or the large veins of the pelvis may be torn, an accident rapidly followed by death. Rupture of the vesical plexus or pudendal plexus may be followed by slower appearance of symptoms. Bell's case is worthy of mention, where a diffuse traumatic aneurism of the gluteal artery developed after fracture of the pelvis. A similar case was reported by Fischer. Bryant has recently reported three interesting cases in which thrombosis of the external iliac artery followed fracture of the pelvis. This was due to overstretching the artery by the misplaced fragments. The intima and media had been torn, whereas the external coat remained intact. In one of these cases gangrene of the leg developed. It should be mentioned that large extravasations of blood after injury of the pelvis may undergo suppuration. (Seydel.)

The sciatic nerve, or obturator nerve, may be crushed, and prolonged neuralgia is then the result. Feré and Perruchet report a case in which a very persistent neuralgia of the obturator nerve followed an apparently simple crush in the sacral region. They were able to produce experimentally a fracture of the ascending ramus of the pubes by applying force to the sacral region. The fracture extended from the iliopectineal eminence to the obturator foramen.

Symptoms.—Splintering of the bone from the pelvic ring usually follows injuries of a more moderate degree, and the diagnosis is not difficult, because of the crepitus and displaced fragments. The conditions are different with fracture of the pelvic ring that are produced by some severe injury, and that are grave conditions even though the organs in the pelvis have escaped. These patients suffer considerable shock, and when conscious groan with pain. As already mentioned, there is not apt to be any external wound, so that fractures and dislocations of the pelvic rings are usually not compound. The degree of shock, however, indicates that there must be some severe injury beneath an uninjured skin.

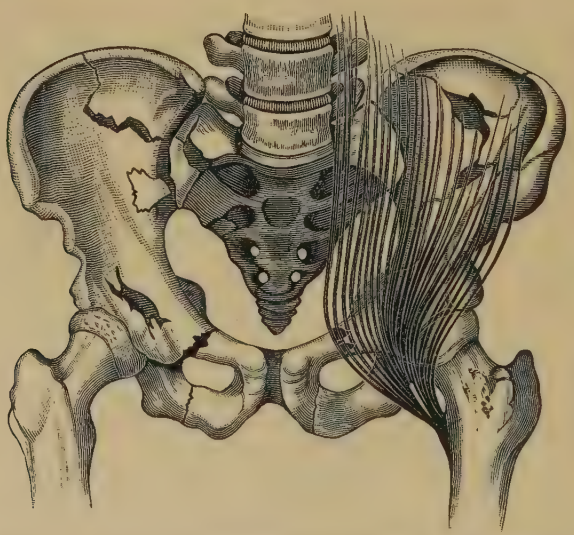
When there is fracture of the pelvis and displacement inward of the anterior portion, the condition is unmistakable even on inspection, as is also simple separation of the symphysis. Malgaigne's double vertical fracture, with marked displacement of the middle section, including the hip-joint, and displacement upward and outward of the anterosuperior spine with the crest of the ilium, is sufficiently characteristic to be recognized on inspection. When certain portions of the crest of the ilium are split off by muscular action, the condition is also sufficiently characteristic to be detected on inspection. In Duverney's transverse fracture of the ilium the displacement upward of the anterosuperior spine and the apparent lengthening of the leg are important. Angular deformity in the region of the sacrum will be in favor of this fracture, and the absence of the normal prominence of the trochanter combined with shortening of the leg is significant of fractures of the acetabulum. When it is not possible by inspection to detect a change in position of the bone, a tape-measure will oftentimes give the desired information.

Diagnosis.—Only in very rare cases is it possible to make a diagnosis on inspection because the fragments frequently return to their normal position. It may be necessary to palpate carefully for the purpose of detecting abnormal mobility and crepitus, especially in the region where fractures are most common. One hand steadies the pelvis while the other palpates the individual portions of the bone. Even without crepitus it may be possible to detect in this way very slight displacement of fragments. It is also justifiable to compress gently the lateral portions of the pelvis or examine through the rectum or vagina. In this way the posterior wall of the symphysis and both rami of the pubes can be felt. Only the upper half of the ascending ramus of the ischium can be palpated, and only the spine of the ischium of the descending ramus. The acetabulum, the linea arcuata, and the upper margin of the sciatic notch can be felt. Along the posterior portion of the pelvis only the promontory, the upper section of the sacrum, and the coccyx can be reached.

Besides the objective signs of fracture, there are the subjective symptoms, such as pain and disturbed function, and indirect signs, such as ecchymoses and symptoms due to involvement of the pelvic

organs that can only be explained by the presence of a fracture of the pelvis. When palpating the pelvis, the presence of pain in one place will always be suspicious of injury of the bone if found persistently on several examinations. One should request the patient to move carefully. If the leg on the injured side cannot be flexed or cannot be lifted from the bed, it may be that the nerves have been injured, or that the iliopsoas muscle has been damaged by displacement of the ilium and is infiltrated with blood or injured by fragments of bone, so that even the slightest amount of motion is painful. This extremely painful motion may be the only sign of fracture of the pelvis. The pointed splinters of bone may produce involuntary painful contraction. (Rose, Katzenelson.) The inability to move the leg may also be due to

FIG. 13.



Comminuted fracture of the pelvis, showing tendency of small sharp fragments to penetrate the ileopsoas muscle. (Hoffa.)

the fact that in fractures of the acetabulum or through the neck of the femur the thigh has lost its point of purchase. In fractures of the acetabulum with displacement of the femur there are also the signs of crepitus and difficulty in keeping the replaced head of the bone in position, which may even be impossible, besides the ordinary signs of dislocation. Crepitus will sometimes be detected the moment an attempt is made to move the bone, which distinguishes this sort of fracture from fracture of the neck of the femur with displacement, because with the latter the crepitus is not felt as a rule until the deformity has been reduced and the fragments have been brought in apposition. (Hamilton.)

Ecchymosis is supposed to be of special value as an indirect sign

in fracture of the acetabulum. Discoloration above the line of Poupart's ligament is significant, because it distinguishes fractures of the acetabulum from intracapsular fractures of the neck of the femur, the effusion of which always appears below Poupart's ligament. (Rose.) In the region of the hip and sacrum, in the perineum, and in the scrotum ecchymosis appears sooner or later, according to the position of the injured bone. The author has reported a case of fracture of the sacrum in which the ecchymosis did not reach the skin for weeks and the effusion of blood was finally removed by aspiration. Ecchymosis, especially that in places that are not subjected to direct violence, is of diagnostic importance.

Injuries of the urethra are also of indirect importance. When this condition is present without the region of the perineum having been subjected to any violence, it is justifiable to assume that there must be some fracture of the anterior wall of the pelvis.

It is hardly necessary to mention that walking is impossible with fractures of the acetabulum, and is hardly possible with other fractures of the pelvis, partly on account of the extreme pain, partly because the leg is no longer properly supported by the pelvis. These patients are unable to raise themselves up after their injury, although exceptions, of course, do occur.

In spite of these direct objective and subjective signs and the indirect signs it may happen that a fracture of the pelvis is confounded with a simple crush of the hip, and the break will not be detected for a long time—*i. e.*, until the callus is noticeable. If one is desirous of ascertaining after considerable lapse of time whether there has been any fracture of the pelvis or not, one should remember that 90 per cent. of the pelves of adults is irregular (Hasse), due to the fact that the spine in its lower portion does not remain perpendicular, but overhangs the margin of the lumbosacral joint to the right or left, whereas the sacrum and coccyx deviate to the opposite side. When the spine overhangs to the right, the right half of the pelvis will be lower and the right lower extremity will appear longer than the left. At the same time the spine from the lumbosacral joint to the middle of the coccyx will be turned to the left and the right half of the pelvis will be more anterior, whereas the symphysis will be turned toward the left. The right lateral mass of the sacrum in these cases is broader than the left, and as a rule the linea pectinea of the brim of the pelvis on the right side is somewhat more marked than on the left. This right half of the pelvis will as a rule be somewhat larger than the left. The position of the tube is important, and the individual should be placed evenly upon the table, because any distortion of the picture may lead to erroneous conclusions.

After making a diagnosis of fracture of the pelvis the surgeon still has to consider what complications are present, especially with reference to the urinary apparatus. It is extremely important to recognize these conditions early because the life of the patient depends upon an

early diagnosis of the existing conditions. Dysuria or anuria does not necessarily indicate an injury of the bladder or of the membranous portion of the urethra, because simple crushes of the abdominal parietes and severe concussion of the pelvis may produce paralysis of the detrusor vesicæ. (Rose and Earle.) The pain frequently noticed in the region of the symphysis and the distinct sense of some internal rupture are absolutely unreliable data. Only when blood trickles out of the urethra is it highly probable that the urethra itself has been injured, or the bladder when with tenesmus bloody urine is passed. Bloody urine may be passed, however, with crushes of the kidneys, as is evident from the cases reported by Leisrink. Examination with the catheter alone gives the desired information, and should be done in every case as soon as the surgeon is called. The best instrument for this purpose is a metal catheter of about No. 25, French, which should be passed very carefully. If the instrument reaches the bladder without obstruction and clear urine is passed, it may be that the urethra and bladder are uninjured. Bloody urine is suspicious. Sometimes only a very slight quantity of bloody urine is passed, and on introducing the catheter further there will be found an elastic resistance, and following this with slight rotation a second cavity will be emptied of partly clear and partly cloudy urine. In this case the catheter is passed through the tear in the bladder into the peritoneal cavity. It is important to know whether the patient urinated any length of time before the accident, because if only a little bloody urine is passed, it is very probable that the bladder is torn, which might easily be the case provided the bladder was full. When the catheter sticks in the membranous urethra, one should remember that primary fractures of the pubic portion are usually associated with complete laceration of the urethra, and that secondary fractures are more apt to crush this structure. In the former case one should desist from the further use of the catheter, because the only way of reaching the bladder is by perineal section, while the catheter is liable to produce false passages.

After the first twenty-four hours two groups of symptoms appear, at first slowly and after the second day more rapidly, and are of distinct diagnostic importance. One group is due to acute peritonitis and the other to urinary infiltration. Swelling of the scrotum indicates some injury to the bulbous portion ; and infiltration above the symphysis and in the groins, with dulness in the lower portion of the abdomen, suggests some injury behind the triangular ligament or some extraperitoneal rupture of the bladder. Rapidly increasing dulness in the lower region of the abdomen would be in favor of intraperitoneal injuries to the bladder. The diagnosis of intraperitoneal injuries of the bladder is very rarely made before death. The question arises whether it is justifiable to wait for the secondary signs and to diminish the chances of success of operative interference. Hellendal suggests sectio alta for the purpose of making an accurate diagnosis, and condemns exploratory puncture and washing out of the bladder recommended by Weir, and

exploratory laparotomy, dividing the abdominal parietes layer by layer, as recommended by Güterbock, MacCormac, and Rose.

When the fractures occur in females, the fragments of the anterior portion of the pelvis may injure the vagina. It is always necessary to examine this region and also the rectum in cases of fracture of the sacrum with displacement.

Prognosis.—The prognosis of fracture of the pelvis depends upon the immediate and remote results. Fractures without involvement of the pelvic organs are usually favorable as far as the immediate result is concerned, and in simple cases demand treatment for one to two months. When they are more extensive, the treatment may last for six months. Those fractures passing through the acetabulum are especially feared. In spite of the severity of the condition, these patients recover provided there are no complications. Some of them do not show any bad after-effects, as is evident from the reports of Leisrink, Riedinger, König, and others.

In most cases of fracture of the pelvis the individual is unable to attend to his ordinary duties for a considerable time, for there is very apt to be sensitiveness, preventing lifting and bending or the carrying of weight, especially with fractures in the posterior region of the pelvis in the vicinity of the sacroiliac joints. Slight œdema at the seat of fracture after prolonged exertion, or distinct thickening as with crushed fractures near the posterior portion of the ilium in the absence of displacement, is often the only sign of any severe injury of the pelvis. A certain rigidity in the sacral region and practically unlimited anterior and posterior motion indicate that recovery has taken place without leaving any further evidence than firm cicatricial masses in the region of the joint. When the seat of fracture is in the posterior portion of the pelvis, recovery is not liable to take place without leaving some deformity. Fractures of the acetabulum, either of the margin or of the fundus, are unfavorable because in old age arthritis deformans is liable to develop.

Fissures of the sacrum, which can sometimes be recognized only by the extreme tenderness and deep-seated hæmatoma, in the absence of crepitus and displacement, may remain very painful for one and one-half to two years after the injury, especially with any attempt to bend or straighten up. Coccygodynia, which is liable to follow injuries of the coccyx, is well known and frequently disappears after removal of the displaced portion of bone.

In females fractures of the pelvis with displacement may be productive of severe after-effects during childbirth. Cases of this sort have been reported by Malgaigne and Kaufmann. Two interesting cases of traumatic anterior separation of the pelvis are reported by Winkler and Neugebauer.

The prognosis of fractures of the anterior portion of the pelvis depends upon involvement of the urinary apparatus. When this has not been injured, recovery may be complete, although involvement of

the obturator nerve may complicate the condition somewhat. When the peritoneal wall of the bladder has been injured, septic peritonitis always follows without operative interference; and when the extra-peritoneal wall of the urethra has been injured, there is always the danger of urinary infiltration and suppuration in the region of the perineum, the scrotum, or in the pelvic connective tissue. When this danger has been overcome by prompt surgical treatment, very persistent fibrous urinary fistulas or strictures of the urethra may remain that demand prolonged after-treatment and interfere largely with the working power of the individual. Only those patients that are intelligent enough to recognize the condition will become permanently cured and remain so. The injuries secondary to fractures of the pelvis are the most unfavorable injuries of the urinary apparatus, because they always open the door to secondary infection of the fracture and of the destroyed tissue. These fractures of the pelvis diminish the working ability of the individual anywhere from 10 to 50 per cent., according to the Vienna statistics, although it is very difficult to determine in an individual case the exact extent of the damage, which, according to the legal decisions, may amount to 100 per cent. of a man's earning power.

Treatment.—The treatment of fractures of the pelvis aims to overcome the shock, to replace the fragments as much as possible, and to meet the complications due to involvement of the pelvic organs.

If examination shows that there is present one or more uncomplicated fractures, the patient should first of all be placed in a suitable position. Fancy bandages, pillows, etc., are uncomfortable, and it is far better simply to place the patient upon his back at first on a water-bed, and keep him in this position by means of sand-bags placed at either side of the pelvis. The legs should be slightly flexed at the hip and knee and the knees supported by a sand-bag or some other pillow.

In fractures of the sacrum or coccyx or of the anterior wall of the pelvis with displacement of the fragments, it is justifiable to attempt to replace these bones through the rectum or vagina. In fractures of the pubes or ischium it may be possible to improve the position of the fragments by tamponing the vagina. It is difficult to do this through the rectum, and only possible by including a large rubber tube in the packing, which allows the intestinal contents to escape. The fragments of the ilium, especially of the crest of the ilium, may frequently be replaced and held in place by sand-bags or swathes.

With double vertical fractures and fractures of the acetabulum, permanent extension should be used. Counterextension should be applied by raising the foot of the bed instead of using perineal straps, which are very painful. The fragment displaced upward and rotated around the horizontal axis may be pulled down and replaced in this manner and kept in place by appropriate measures.

Simple concussion of the pelvis may produce paralysis of the rectum

and bladder, so that these organs should be attended to. When there is dribbling of urine, it is not simply necessary to furnish a permanent urinal, but the perineum should be padded so as to prevent bedsores caused by the urine dribbling down backward.

When there is reason to suppose that the bladder has been injured, the abdomen should be opened provided the condition of the patient allows. Hellendal's statistics show that it is advisable to allow the immediate shock to pass off, although the operation should be done within the first twenty-four hours if possible. The pelvis should be raised. A transverse incision above the pubes exposes the bladder, and if an intraperitoneal operation is necessary, a vertical incision in the linea alba may be added. An extraperitoneal tear of the bladder is sewed in the ordinary manner with two layers of catgut sutures. The success of the suture is tested by filling the bladder with water. This experiment may also indicate a second tear which had been overlooked. When the peritoneal cavity has been involved, it should be washed out in the usual manner. The suggestion to drain the bladder through a suprapubic incision when the bladder has been sewed up through the abdominal cavity is good, generally speaking, although in cases of injury of the bladder associated with fractures of the pelvis it has the disadvantage that the fractures and crushed soft parts of the anterior portion of the pelvic ring are constantly wetted by urine and are liable to become necrotic and infected. It is therefore better to make use of a peritoneal incision. With extraperitoneal tears of the bladder drainage is unnecessary. The bladder should be sewn up and catheterized at stated intervals. When the urine is normal, the wound suture will hold at least until the wounds in the pelvis have commenced to granulate. Those wounds in front of the pelvis, of course, are closed partially and carefully packed.

Where the urethra is simply crushed and it is easy to catheterize the patient, and urine cannot be voided chiefly because of the perurethral effusion of blood, it is not well to make use of a permanent catheter because of the danger of infection and bedsores. One should catheterize regularly and wait to see whether the urethra does not recover. Should this not be the case, and should there be a rise of temperature with swelling of the perineum and tenderness, a perineal incision should be made immediately. (König-Kaufmann.) This prevents infection of the injured bones and soft parts from the urethra. Early perineal incisions give the best results in any form of injury of the urethra, but especially in fractures of the pelvis, and should always be made use of when the catheter can no longer be employed. On opening the perineum one can easily recognize the central end, which will present as a bleeding prominent point, or when irrigating will appear as a strand floating free. If needs be, an attempt may be made to empty the bladder by pressure from above, or a suprapubic opening may be necessary and catheterization from within. A permanent catheter may be placed throughout the entire urethra, or the

proximal end of the urethra may be temporarily fastened into the wound. When it is possible, however, the portions of the urethra near the symphysis should be united and an incision made along the united urethra, which changes the transverse wound into a longitudinal wound and thereby diminishes the chances of subsequent stricture.

DISLOCATIONS OF THE PELVIS.

The same forces that produce fracture of the pelvis may also separate the individual bones forming this structure. When the articulations are separated and the ends of the bones displaced, the condition is spoken of as a dislocation; but when the joint is simply opened with rupture of the ligaments, the condition is termed a separation. Dislocation predisposes damage to at least two of the joints, and Linser is therefore correct in subdividing these conditions into two varieties:

1. Dislocation of one half of the pelvis, due to involvement of the sacroiliac joint behind and the symphysis in front; and,
2. Dislocation of the sacrum with involvement of both sacroiliac joints with or without involvement of the symphysis.

Dislocations of the pelvis are far more uncommon than fractures, and are almost always associated with fractures. The clinical picture resembles that of fractures, and the treatment and prognosis depend upon the same conditions mentioned in connection with those injuries. It should be mentioned that the urinary apparatus is very likely to be involved when the symphysis has been ruptured. This joint may be separated so as to allow the introduction of three fingers. The intra-articular cartilage is usually torn off on one side and adherent to the other. This condition is found after severe labor cases or after falls upon the symphysis, etc.

With separation of the sacroiliac articulation the entire hip may be prominent anteriorly and externally, and when the entire sacrum is displaced the symptoms resemble those of Malgaigne's fracture, so that it is frequently impossible to make a differential diagnosis. Moreover, fractures are also liable to be present. When there is no bony crepitus and only soft crepitus, it is presumable that the joint alone is involved. A good Röntgen ray apparatus will furnish a correct diagnosis.

Dislocation of the sacrum is most unfavorable. The majority of the patients die, and almost half of the cases of dislocation of one half of the pelvis succumb.

CRUSHES OF THE PELVIS.

Simple contusion of the pelvis rarely produces severe symptoms. Sometimes superficial crushes are followed by extensive extravasation of blood into the subcutaneous tissue, especially in fat people, where

the hemorrhage becomes evident in the gluteal region or in the region of the sacrum. There is a superficial fluctuating mass exposed to all the dangers of any effusion of blood, which therefore should be removed as early as possible by aspiration. Crushes in the gluteal region may be complicated by injury of the sciatic nerve. The immediate result is weakness of the leg, which may rapidly disappear or be followed by long-continued sciatica. When there is no characteristic point of pressure, and should there be no emaciation, it may be impossible to determine whether the patient's statements are correct or not.

Treatment.—The treatment of simple bruises of the pelvis consists in appropriate position until the primary tenderness has passed away. Massage, baths, and careful attempts at walking should be tried early. When the crush is severe, convalescence may be somewhat delayed, and one should always bear in mind that some fracture of the pelvis may have been overlooked.

WOUNDS OF THE PELVIS.

Stab-wounds.—These are subdivided into those produced by a sharp instrument and those produced by more or less pointed objects upon which an individual has fallen. Stab-wounds in the strict sense of the word are only of interest when large vessels, such as the gluteal artery, have been injured. Fischer has called attention to the fact that wounds in this region involving vessels are very uncommon, because these structures are well protected by the bones and by their deep position. Marked hemorrhage following a stab-wound of the buttock, especially if recurring, is always suggestive of some injury of the large vessels. The vessel affected may sometimes be indicated by the wound itself. Should the stab have been inflicted into the upper portion of the gluteus maximus, it is probable that the gluteal artery has been injured, whereas wounds lower down are more liable to affect the sciatic artery or the internal pudic. When pressure does not check a hemorrhage, the wound should be enlarged and the vessel tied.

Cases have been reported in which there was no marked primary hemorrhage and attention was called to injury of the artery by a secondary hemorrhage. Wahl's sign should always be sought for in injuries in this region, and consists in a blowing or rubbing murmur synchronous with the pulse, indicating incomplete division of some larger artery.

Stab-wounds of the gluteal artery show a tendency to be followed by diffuse traumatic aneurism. The hemorrhage does not reach the surface, but spreads in the soft tissues. This is not surprising, considering the diagonal course of the long wound. After development of an aneurism of this sort, the supplying artery may be tied according to the method recommended by Anel. When this is not possible on account of the size of the mass, the sac should be opened and the bleed-

ing point compressed with the fingers. The sac should then be completely divided. In spite of great precaution and rapid operating the bleeding is frequently very great, although it may be somewhat controlled by compressing the abdominal aorta. (Trepper.) The surrounding vessels should all be tied off.

The second variety of injuries, where the patient falls on some pointed object, is comparatively uncommon. Neumann found only 16 cases in 16,000 injuries. The region involved is usually the perineum, and the gravity of the injury depends largely upon whether the object penetrates the interior of the pelvis or not. When this is not the case, severe complications do not arise as a rule. Even when the pelvis is penetrated, the peritoneal cavity is not often opened. Should the pointed object penetrate the pelvis beneath the anterior ring of the pelvis and then pass upward beneath the skin until it reaches the chest, the peritoneal cavity is almost sure to be opened. This typical injury will be considered later. All these injuries have in common that they usually involve the preperitoneal or retroperitoneal connective tissue and pass upward along the wall of the pelvis and along the abdominal wall or penetrate the ischiorectal fossa. The extent and nature of an injury of this sort can only be detected by careful examination of the wound and by enlarging the canal. With extraperitoneal wounds the track should be carefully cleansed and the hemorrhage stopped by packing. When there is any suspicion that the peritoneum is involved, the abdomen should be opened.

Gunshot-wounds.—Surgeons distinguish simple gunshot-wounds of the soft parts, then those involving soft parts and bone, and finally those involving the pelvis and pelvic organs. Flesh-wounds produced by any sort of projectile are usually favorable, provided the track is not deep and does not involve some large vessel. The prognosis is not quite so favorable when the projectile strikes crosswise, or has become flattened by striking some object previously, or when foreign bodies are carried into the wound. These conditions are recognized by the irregular appearance of the wounds of entrance and exit. Should these wounds become secondarily infected, the condition may be very grave indeed.

Küttner has described gunshot-wounds of the thigh, found in soldiers that fired while resting on one knee. The wound of entrance was along the anterior and outer surface of the thigh, and the wound of exit, if present, was always in the posterior gluteal region. The bullet track was sometimes 40 cm. (16 inches) long.

Gunshot-wounds of the bone differ, of course, from the ordinary bone injuries in that they are always compound. The bone may be either grazed or perforated, or there may be multiple splinters, especially in the anterior region of the pelvis and in the region of the ischium. Stromayer has called attention to the fact that those gunshot-wounds of the pelvis are most dangerous where the projectile entered from behind, because the long bullet track through the thick

muscles favors suppuration. Besides this the loose connective tissue in the interior of the true pelvis favors purulent infiltration. The veins of the spongy portion of the bones in the pelvis are freely connected with the large veins of the abdomen, so that osteophlebitis and pyæmia, even when the pelvic organs are not involved, are conditions always to be dreaded.

Of 698 wounded in 1870–71, in whom the bones of the pelvis were involved in compound injuries, 228 died—*i. e.*, 32.6 per cent. Of these, 63 died of pyæmia and only 20 of secondary peritonitis. It should be mentioned that 35 cases of gunshot-wounds of the ilium showed 11 cases of recovery, and that 6 cases of fracture of the pubes showed 1 case of recovery. Only 1 of the 5 cases of fracture of the ischium survived; the rest died of suppuration. Gunshot-wounds involving the pelvis itself, especially the acetabulum, were greatly dreaded. Those of the sacrum were also dreaded on account of the proximity of the rectum, for 35 of 78 cases died—*i. e.*, 44.9 per cent. It should, however, be added that these figures included the crushes without external wounds, so that the mortality of gunshot-wounds proper is really much worse.

Gunshot-wounds of the anterior portion of the pelvis are most unfavorable; next come gunshot-wounds of the sacrum, and finally those of the ilium. According to Küttner, these are quite favorable, as shown by the experience in the late Anglo-Boer War. Modern methods and modern firearms will probably influence these figures considerably. The German army revolver and Mauser's self-loading pistol produce approximately round holes. A small-calibre firearm produces clean round holes of the ilium, and even in places where there is considerable spongy bone the results of hydraulic pressure are seldom seen. The hard bones in the anterior portion of the pelvis, and especially the ischium, are apt to be splintered. The great power of penetration of modern arms, combined with the tendency to splinter the bones, explains the frequency to pelvic complications. The author will only mention the extraperitoneal injuries of the bladder. Compared with injuries of the bladder, with simple fractures, extraperitoneal wounds of the bladder in connection with gunshot-wounds of the pelvis have a distinctly better prognosis, because the external wound favors the escape of urine and prevents urinary infiltration. According to Bartels, the urine usually streams out through the wound immediately, whether this is produced by the ball itself or by splinters of bone. This flow of urine, with or without blood, may be the only evidence of injury of the bladder. Within a short time the bullet track or the wound track becomes occluded by swelling. Sloughs are sometimes separated after considerable suppuration and high fever. This is the time when urinary infiltration is likely to take place, and is the critical period for the patient on account of the torturing urinary tenesmus, restlessness, and excitement. After these sloughs have been cast off the urine flows

freely through the channel. This gradually closes, usually within three weeks to three months, or a permanent vesical fistula remains.

The condition is sometimes complicated by bony sequestra. Splintered-off pieces of bone may enter the bladder at the time of injury or later. According to Ungerer, splinters of bone were found in the bladder in 66 per cent. of the gunshot-wounds of the pelvis. Bits of clothing and bullets have also been found there. Involvement of the rectum is an unfortunate complication, and feces as well as urine will be discharged through the wound. Gunshot-wounds with a wound of entrance in front and a wound of exit behind are the most favorable, and the most unfavorable are those that show a wound of entrance behind without any wound of exit.

The first principle in treating any of these wounds is not to infect the track with dirty fingers or with a probe. The character and position of the wound of entrance, and the seat and appearance of the wound of exit, the general condition of the patient, and the history will give sufficient information to guide the treatment.

When there is only a slight amount of shock and the external wounds show but little bloody secretion, or are dry and seared, and should the position seem to indicate that only the soft parts are involved, it is best to apply simply a dry antiseptic bandage and await developments. When the wound of entrance is in front over Poupart's ligament and the wound of exit behind above the crest of the ilium, it is justifiable to assume that the bullet has followed along the bone, provided there are no symptoms referable to the pelvic organs. With modern projectiles this is an extremely uncommon occurrence. It is never justifiable to hunt for a bullet that is producing no symptoms, although the patient should be carefully watched.

The chief dangers are due to involvement of the bladder and large vessels. The secondary hemorrhages that appear several days after the injury are especially feared. In those cases the track should be opened up as freely as possible and the vessel tied. Sometimes it may be necessary to abandon any attempt in this direction and simply pack down to the bleeding vessel.

In extraperitoneal wounds of the bladder, or when the urethra has been torn, urine usually flows out of the wound. With intraperitoneal injuries of the bladder, however, that may be extremely difficult to recognize, the conditions are quite different. Sometimes it is necessary to open the abdominal cavity for the purpose of diagnosis. This operation may be done even in time of war with considerable hope of success, because it is sufficient to operate twenty-four hours after the injury or even later, during which time the patient may be placed in appropriate surroundings. In these cases an aseptic protecting bandage should be applied immediately. The outcome of intraperitoneal intestinal wounds is decided within the first few hours after the injury has been inflicted. The portion of the intestine within the pelvis contains many bacteria that are extremely dangerous to the peritoneum.

In times of peace, where all the accessories can easily be had, it is justifiable to open the abdomen; for instance, if a gunshot has penetrated the pelvis in front or behind; and should an aseptic probe in the absence of a wound of exit become lost within the pelvis itself, it would be justifiable to perform a laparotomy even in the absence of intestinal symptoms, so as to determine the exact condition.

Should urine or fecal matter escape through the wound, the patient should be placed in such a position that the drainage is as good as possible. The bandage applied is extremely simple and consists of some absorbent material, such as fluffed gauze, which should be frequently changed. The region around the wound should be carefully greased or protected with some powder (Lassar's paste), so as to prevent eczema. Operative interference is indicated only when there is some obstruction to drainage, as shown by local swelling with a rise in temperature. The wound should then be dilated, and, if necessary, counteropenings made or the perineum split. After this it may be possible to remove splinters of bone and make an otherwise complicated cavity extremely simple. The same steps may have to be taken when there is simple retention of pus outside of the pelvis. After the ball has been successfully removed, the disturbing cause may have been overcome and the painful inflammation of the surrounding tissues rapidly subsides. It may be extremely difficult to find the bullet, and if one were simply to follow up the track the wounds inflicted would be enormous. The *x*-ray is of great value in this connection, although in time of war, because of their weakened condition, it is often not possible to bring the patients to the apparatus and place them in the appropriate position. The task is much more difficult when the connective tissue of the true pelvis is involved, especially around the bladder and rectum. It may be necessary to perform an extensive bone operation, such as trephining the ilium behind the acetabulum or resection of the sacrum. Suppuration due to gunshot-wounds may persist for many years in this region, as in a case reported in which a piece of bone, probably from the margin of the sciatic foramen, was removed through the rectum. There are still living individuals with sinuses due to injuries of the pelvis received in 1870–71.

COCCYGODYNIA.

This condition may be the result of direct injury of the coccyx, although many other etiological factors have been enumerated by Simpson. The condition may be present with or without palpable change of the bones. With difficult labor the entire coccyx may be displaced backward or bent backward, or the ligaments are stretched, or the coccygeal nerves have been too greatly pressed upon. During the puerperium there will be a dull pain in the coccygeal region, which increases on sitting up, moving about, or at any time when additional pressure or traction is made upon the coccyx. The condition is most

common in females and plays a part in a large number of the diseases peculiar to the female genital apparatus.

Treatment.—The treatment should depend upon the etiological factors, and consists in the use of antiphlogistics and antineuralgic measures, such as sitz baths, tincture of iodine, belladonna suppositories, and electricity. The faradic current has been used with great success by Seeligmüller and Gräfe. When these measures do not give relief and bony changes can be made out, excision of the coccyx should be considered. This may be done through a posterior median incision. The bone should be resected subperiosteally and the cavity packed with gauze. The skin-incision should be closed except at the lower end. The dressing should be done very carefully because of the proximity of the rectum.

CHAPTER III.

DISEASES OF THE PELVIS.

INFLAMMATORY AFFECTIONS OF THE PELVIS.

THERE are two inflammatory conditions common to the pelvis: osteomyelitis and tuberculosis. They are often confounded with one another, especially when the former develops slowly. In these cases the discharge of typical sequestra after opening the sinus will show the true nature of the disease. The clinical picture in both conditions may be identical, although the pathological conditions and the primary cause are different. It may often be impossible to make the diagnosis before exposing the focus. It should be remembered that osteomyelitic sequestra may be entirely absent, because in osteomyelitis of the spongy bone there may be no necrosis of large pieces, only small sequestra that are dissolved by the granulations. The presence of caseous foci, of course, indicates tuberculosis. It may be said with a certain amount of reservation that the inflammatory processes that start in the bones of the pelvis are usually osteomyelitic, whereas the chronic inflammations that involve the joints first and then extend to the bones are largely tuberculous.

Acute Osteomyelitis.—During the last ten years osteomyelitis of the flat bones of the pelvis has become more defined, thanks to the work in Bruns' clinic. Still, the condition is quite infrequent. This does not apply so much to the ilium, which is very apt to be affected by osteomyelitis, as to the sacrum, for there are few typical cases reported in which this bone was involved.

The condition may seem to be spontaneous or may follow some trauma, and in the early years of life there may have been a preceding sore throat. Lexer reports a case of fatal osteomyelitis in a child eight weeks of age. The ilium was involved. In a certain number of the cases there is a history of a previous blow or of some injury of the pelvis, although this is only an accidental cause that favors already existing disease by furnishing media for the bacteria. The ilium itself or the sacrum itself may be involved, or there may be osteomyelitic foci elsewhere. Osteomyelitis of the ilium occurs in two forms. In the diffuse variety the entire ilium is involved. The bone at the onset may be congested and softened, or may rapidly show the presence of pus foci of varying size which lift the peritoneum off both externally and internally. After union of the acetabulum with the main portion of the ilium, which has usually taken place in children over eight years of age, the hip-joint is very liable to become involved because of the

absence of this protecting layer of cartilage. It is not uncommon to have the sacroiliac joint also involved. In the circumscribed variety the denser portion of the bone in the vicinity of the acetabulum or the region of the crest or spine of the ilium is attacked. The spongy bone of the crest of the ilium and of the spines of the ilium does not become developed until late, so that it is quite easily understood why young children are more liable to have circumscribed osteomyelitis in the region of the acetabulum, whereas in older children the process is more liable to be peripheral. Chronic osteomyelitis of the acetabulum may resemble tuberculous hip disease very closely.

When the sacrum is involved, the lateral masses are principally attacked. The inflammation may extend toward the vertebral canal and produce secondary pachyleptomeningitis spinalis. (Spiess.) The adjoining joints—*i. e.*, the sacroiliac joints—are hardly ever involved, which is probably due to the fact that the epiphyses persist as a rule very late—*i. e.*, until the end of puberty. This may also be the reason why osteomyelitis of the sacrum develops late, because there is the greatest physiological irritation in this region during this period. The anterior portion of the pelvis has but little spongy tissue, and osteomyelitis in this region is extremely rare. (Landerer, Kirschner.) Inflammation of the epiphyseal line of the acetabulum is a separate condition. (Bardenheuer.) Suppuration of the hip-joint takes place early, although there are cases that come under treatment before this has occurred. One will then be able to detect through the rectum an abscess in the region of the acetabulum, while the hip-joint still remains free.

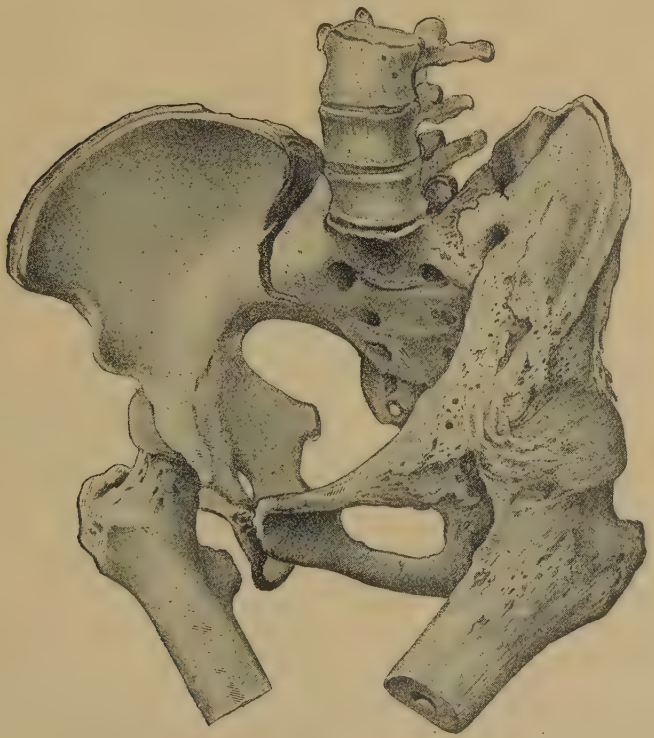
Symptoms.—The clinical picture of osteomyelitis of the pelvic bones corresponds largely to that of osteomyelitis of the long bones. There are cases of varying intensity, those that terminate fatally and slight cases with only circumscribed necrosis or none at all. Diffuse osteomyelitis of the ilium and sacrum is especially feared. Not one of the 5 cases of acute osteomyelitis of the sacrum collected by Hahn recovered; and when the ilium is involved, the prognosis is not only affected by the area of the bone involved, but by secondary disease in the hip-joint. All of the fatal cases showed severe general symptoms from the first and the autopsies showed extensive lesions. The malignant cases are usually diffuse, and benign cases have circumscribed areas of disease. Examination of the blood for micro-organisms is very important prognostically. (Canon.)

The onset is always sudden; even in the cases that come under treatment late with sinuses it is possible to obtain a history of a painful febrile attack. The acute symptoms gradually disappear and a swelling follows that increases until the abscess finally opens. Sometimes the constitutional symptoms are so severe that the local disease is comparatively insignificant. There may be high fever, chills, delirium, great weakness, intestinal symptoms, and pain that is deep-seated and increases on pressure over the sacral region. When the

ilium is involved, there may be pain in the region of the hip-joint, to which region these patients usually refer their symptoms. The more evidence there is of septic infection—*i. e.*, the graver the general symptoms—the more likely the condition to be osteomyelitis. .

Diagnosis.—If localized swelling appears over the sacrum, the ilium, or the hip two to three weeks after the onset, with distention of the subcutaneous veins, the diagnosis will be almost certain, and other infectious conditions due to typhoid or acute articular rheumatism can be ruled out. When the general symptoms are less pronounced, and

FIG. 14.



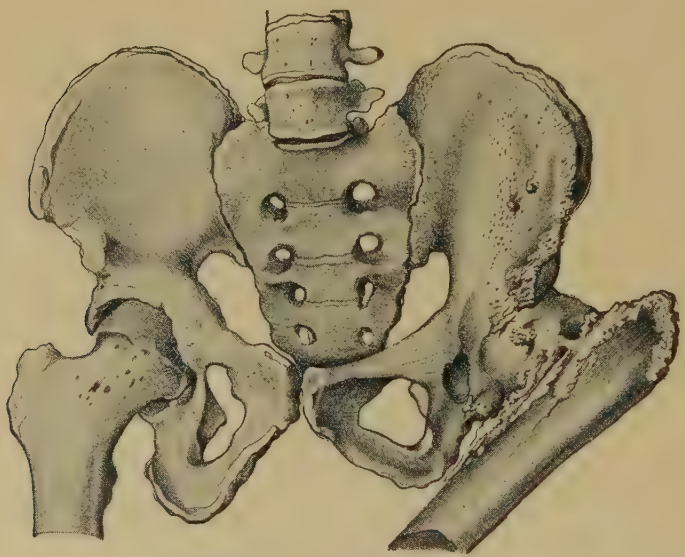
Healed osteomyelitis of left ilium. (Albert and Kolisko.)

when the local conditions develop gradually, the diagnosis is very difficult. The case is still more obscure when the general condition is but slightly affected with a moderate evening temperature, and very gradually developing local signs. Osteomyelitis or periostitis on the internal surface of the sacrum or ilium that develops slowly may not be detected for some time. When there is some inflammation or osteomyelitis in some other region of the body, it may be easier to come to a definite conclusion.

In chronic osteomyelitis with sinuses leading to the ilium, the bony

thickening and the changes in the pelvis may enable a correct diagnosis, especially if the changes in shape are due to involvement of the sacroiliac synchondrosis. This joint becomes obliterated and the corresponding half of the sacrum does not develop, so that the pelvis remains constricted on this side and presents a condition known as Naegele's pelvis. If one has an opportunity to examine a pelvis of this sort after it has been cleaned, the outer and inner surfaces of the ilium will be found covered with osteophytes and small cavities that communicate externally by sinuses. The bone is much thickened and the corresponding ala of the sacrum is narrowed. The hip-joint is almost always affected. There may be bony or fibrous ankylosis or dislocation with or without ankylosis. Involvement of

FIG. 15.



Coxalgic pelvis. (Albert and Kolisko.)

the hip-joint may lead one to suspect that the inflammation is of tuberculous nature, but the abundant formation of osteophytes on the ilium and the extensive thickening of the bone, obliteration of the sacroiliac joint, and narrowing of the pelvis on the diseased side, while in hip disease the narrowing takes place on the healthy side, will enable a correct diagnosis. The accompanying diagrams of Albert and Kolisko represent these conditions much better than any description, and illustrate the fact that in the vast majority of cases primary disease of the pelvis is of osteomyelitic nature, whereas primary disease involving the hip-joint itself is more apt to be tuberculous.

Treatment.—The treatment of osteomyelitis is, of course, surgical; but the time and the extent of operation vary greatly in individual

cases. The acute cases should be distinguished from the chronic cases, and the early cases should be subdivided into benign circumscribed and malignant or extensive cases. When the constitutional condition is little affected, it is allowable to defer operative interference until the abscess can easily be detected. After this has been opened, one may find nothing more than a small rough place on the outer surface of the ilium or on the posterior surface of the sacrum. This amount of interference will sometimes be sufficient without secondary operations upon the bone. When there is high fever or marked local tenderness, one should cut down upon the swelling even when there is no fluctuation. It will sometimes be possible in this way to find considerable pus with only slight involvement of the bone. The amount of operative interference may be sufficient in these cases, and the small sequestrum will separate spontaneously and the wound heal rapidly.

The indications are different in cases of acute osteomyelitis in which the ilium or sacrum is involved over large areas, and in which the constitutional symptoms are marked. Schede reports only 1 death out of 12 cases, and considers that the success is due to early operation. He always attempts to chisel off all the bone involved. Bergmann defends similar views, and recommends total resection of the ilium as practised especially by French surgeons.

Bergmann reports 4 complete and 3 partial resections of the ilium. Two of the complete resections died. The technic of the operation is as follows: An incision is made along the crest of the ilium and the bone is chiselled through below the epiphyseal margin, so as to leave the crest with the attached abdominal muscles. The pubes and ischium are separated through the line of junction, which will leave the head of the femur exposed in the wound. In children under eight years of age there is as yet no bony union between the acetabulum and the flange of the ilium, so that the ilium may be separated from the acetabulum without involving the joint. The final result of these extensive operations is said to be good, if the crest of the ilium with its muscular attachments is preserved. New bone forms rapidly because the two large periosteal surfaces are approximated.

In recent cases of severe osteomyelitis of the sacrum Dehler recommends early radical interference. All 3 of his cases, however, died on account of marked general infection.

Septic inflammation of the epiphyses also demands early interference. Bardenheuer recommends an incision from the middle of the symphysis to the outer third of Poupart's ligament. The peritoneum is stripped off from the true pelvis as far back as possible, which will give a good view of this region and enable one to open any abscess or resect a diseased acetabulum. The iliac artery and veins should be retracted outward with large blunt retractors.

Chronic osteomyelitis with discharging sinuses demands extensive splitting up of the sinuses and removal of sequestra or granulations. The sequestra themselves need not be large to produce suppuration.

Sometimes this operation is easy, although it may be difficult when there are large sequestra along the inner surface of the ilium. It may be necessary to trephine the ilium or separate the soft parts from the crest of the ilium so as to be able to reach the pelvis. Larghi, in 1845, was first to introduce the above-described operation, which has since been made use of by Bergmann in acute osteomyelitis. The sequestra of the ilium and sacrum may be so situated that they cannot be reached, and the patients gradually succumb to the prolonged suppuration.

Tuberculosis of the Bones and Joints of the Pelvis.—It cannot be denied that primary tuberculous ostitis of the pelvis does occur. König states that the middle portion of the sacrum may become carious independently. When the ilium is involved, the disease will usually be found in the thicker portion of the bone behind the acetabulum. It may extend to the hip-joint; or it may involve the symphysis (Hennies, Büngner) and the pubes, the ischium, and regions where osteomyelitis is uncommon on account of the absence of spongy bone. These foci may be perfectly independent of any involvement of the hip-joint.

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In this section will be considered only tuberculous inflammation of the sacroiliac joint. This joint is a true joint with cartilage covered with synovia, and the pathological changes resemble those in other joints. It is, however, rarely attacked. The patients are usually males between twenty and thirty-five years of age. It may be that the late development of these regions is an etiological factor for tuberculosis just as it was for acute osteomyelitis of the sacrum. Trauma is the second and most apparent cause. Up to the present time only one observation has been reported of possible primary synovial disease. (Golding-Bird.) Erichsen describes a case in which the cartilage and synovia were destroyed although the bone was only a little roughened. Ordinarily the disease begins in a focus in the sacrum that involves the joint secondarily. Although the condition begins primarily outside of the joint, one is justified in considering the condition a joint-affection because the neighboring bony structures really belong to the articulation. In cases in which the process breaks into the joint itself extensive inflammation, of course, is the inevitable result. Sclerotic processes usually develop around the focus, and connective or bony union between the opposed joint-surfaces takes place. When the tuberculous disease has involved the joint itself, the area infected is circumscribed. Delbet calls this common variety partial inflammation of the sacroiliac joint. There are two varieties of inflammation: caries sicca and a fungous variety with serous effusion that later becomes purulent. When farther advanced, the pus ruptures the ligaments in the posterior region of the joint, or, more commonly, in the anterior region, and then travels downward into the pelvis. The bones that form the joint—*i. e.*, the posterior portion of the ilium and the sacrum—become carious. When the disease is bilateral,

the destruction of the sacrum may be extensive. Tuberculosis of the sacroiliac joint is a very insidious disease, especially in its early stages. The first, and oftentimes the only, sign may be slowly increasing pain. This pain is frequently localized over the sacroiliac joint, or in the region of the anterosuperior spine, of the flexors of the thigh, the anterior surface of the thigh down as far as the knee, in the gluteal region, or along the posterior region of the thigh. It will be found on careful examination that the pain corresponds to sciatic pain, and that the variation is due to the original seat of disease involving different nerve-trunks. Motion in the sacroiliac joint, standing or walking, or even prolonged sitting—that is, any condition overtaxing the joint—may increase the amount of pain. Pressure upon the joint has a similar effect. This may be done by compressing the joint transversely, or palpating the posterior line of the joint or the anterior region through the rectum or vagina. This period, in which there is marked pain as the only symptom, may lead one to conclude that the condition is a very obstinate sciatica. This stage may last for months up to two years. When the pain is constant or very violent, it produces certain attitudes and disturbances of gait. The weight of the body on standing or walking is borne by the healthy side. The diseased half of the pelvis is rotated forward and somewhat depressed. The result is an apparent lengthening of the corresponding leg. Sometimes there may be an apparent shortening. This shortening or lengthening and the distinct scoliosis present in certain cases disappear on lying down. Compared with hip-joint disease that produces a similar condition of the body, it should be remembered that the movements of the hip-joints are in no way limited. Even in the early stages there is slight emaciation of the leg, although this is not pathognomonic of the disease, but it may first call attention to the severity of the condition.

After a period of pain lasting for a varying length of time new symptoms develop. If the inflammation is chiefly along the posterior surface of the sacrum, a doughy swelling appears along the line of the joint. This mass gradually becomes more distinct, especially with atrophy of the gluteal muscles; and when the abscess extends, it reaches the surface along the line of the muscle-fibres. It is more common to have the inflammation in the anterior region of the sacrum. An internal examination will show the distinct swelling, especially if the two sides are compared. This swelling increases and a cold abscess becomes evident. The pain formerly so violent gradually diminishes, which is probably due to the fact that the nerve-trunks are no longer pressed upon to such a degree. Up to the present time the general condition may not have been greatly interfered with, although after rupture of the abscess and with secondary infection the appetite disappears, the patients become emaciated, there is an evening rise of temperature, often with complications in the lung, and the individuals succumb provided the process is not successfully interfered with.

The prognosis and the course of caries sicca are more favorable. This affection may produce almost no symptoms until a cold abscess attracts attention to the condition.

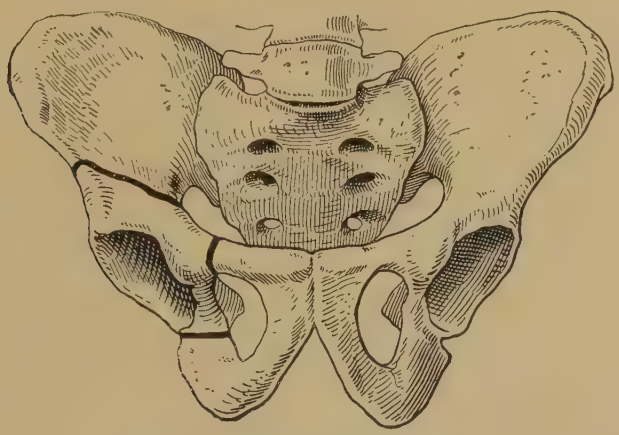
Diagnosis.—There are two conditions that may be confounded with tuberculous inflammation of the sacroiliac joint: sciatica, or pain in the region of the sacral nerves, including lumbar neuralgia, and tuberculous or chronic osteomyelitis of the hip-joint. Tuberculous sacroiliac disease usually occurs after puberty. The onset is insidious, and there will be found no involvement of the hip-joint. Sciatica, pure and simple, is usually found later in life. It should always be remembered that the sacroiliac joint may be involved as a metastasis in purulent inflammations, by gonorrhœa, or by arthritis deformans. If suppuration has taken place, the diagnosis may be easier, although one should always consider the conditions that may lead to suppuration within the pelvis.

Treatment.—The treatment of tuberculous ostitis is similar to that of chronic osteomyelitis. The sinuses should be opened, the foci curetted, and the carious pieces of bone chiselled off. In tuberculosis of the symphysis a considerable portion of the anterior ring of the pelvis may be resected without fear of destroying the function. (Büngner.) Tuberculous sinuses that discharge only a slight amount may be made to close under constitutional treatment and local application of iodoform. Unfortunately, operations upon sinuses that do not discharge much are very apt to terminate in anything but the desired result. They discharge more freely, and patients begin to run down because of the secondary infection.

When the acetabulum is extensively diseased, it may be resected after the method recommended by H. Schmid. The body of the ilium, the horizontal ramus of the pubes, and the body of the ischium must be divided. (Fig. 15.) The head of the femur is lifted out of the acetabulum through Langenbeck's incision for resection. The thigh is rotated outward and abducted. A second incision is made at right angles from the middle of the first through the muscles and skin down to the bone and carried forward as far as the anterosuperior spine. The muscles are next separated from the external surface of the ilium by blunt dissection. The periosteum is lifted off in front at about the level of the inferoanterior spine, and the dissection carried inward beneath the pelvic fascia on the inner surface of the squamous portion of the ilium until the greater sciatic notch has been reached—*i. e.*, to the place corresponding to which the soft parts have been separated externally. This region of the bone is then divided with a saw or chisel, care being taken not to injure the pelvic fascia. This is the most difficult step of the operation. Next, the soft parts with the periosteum are separated for about 1 to 3 cm. (0.4 to 1.2 inches) from the horizontal ramus of the pubes, starting at the inner margin of the acetabulum. The vessels are retracted inward. An aneurism-needle is passed around the horizontal ramus through the obturator foramen

and the bone is divided with a chain-saw. The femoral artery and vein are left over the remaining portion of the pubes. The third step of operation consists in pulling a little outward the acetabulum that has already been freed on two sides. The soft parts with the periosteum are then separated from the ischium from above downward. The aneurism-needle should be passed close to the bone so as not to injure the vessels and nerves in the obturator foramen. The bones should be divided about 2 cm. (0.8 inch) below the acetabulum with a chain-saw. The acetabulum is then grasped with lion forceps, any remaining soft parts are divided, and the fragment extracted.

FIG. 16.



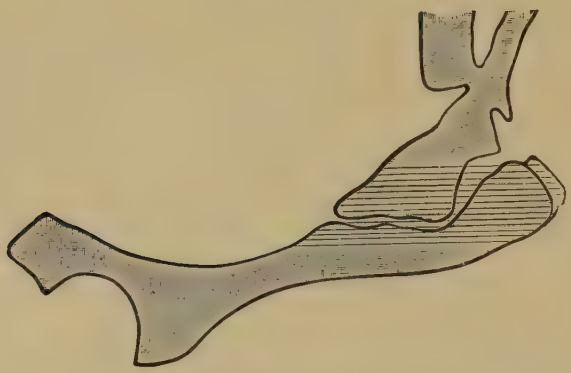
Resection of the acetabulum. (Schmid.)

The treatment of sacroiliac disease should not be operative at first. In the early stages when there are no abscesses or sinuses the treatment should be conservative. The joint should be immobilized if possible by rest in bed and plaster-of-Paris cast. Sayre claims good results from conservative treatment. Later he allows his patient to walk during the day on crutches and high sole. He immobilizes the joint by means of a pelvic band. Besides these measures he makes use of counterirritants, such as tincture of iodine. At night the patients have an extension apparatus applied. After two or three months improvement is evident, although a pelvic band must be worn for some time. (Van Hook.)

If the disease progresses and suppuration takes place, injection of iodoform may be tried. When the abscesses are along the posterior surfaces of the sacrum, this form of treatment is usually useless on account of the shape of the abscess. These abscesses usually have a superficial cavity that communicates with the cavity of the bone by means of a narrow opening (Delbet), so that the iodoform does not reach the primary focus at all, and operative interference becomes necessary. There are several ways of operating:

1. Exposure of the sacroiliac joint according to Delbet. An incision is made corresponding to the greatest diameter of the abscess. After emptying the superficial pus cavity Delbet follows along the sinus that always exists, curettes the lesion in the bone or chisels the carious portion away, and then resects the joint itself so as to reach the anterior surface for the purpose of treating foci in this region in the same way. Fig. 16 illustrates the operation.

FIG. 17.



Exposure of the sacroiliac joint after Delbet. (Waz.)

2. Exposure of the sacroiliac joint after Schede. A curved incision is made from the posterior portion of the crest of the ilium downward to the sacrum. This incision is about 3 to 10 cm. (1.2 to 4 inches) long. After chiselling off the overlying portion of the ilium the joint is sufficiently exposed. Most operators prefer this operation.

3. Resection of the sacroiliac joint after Bardenheuer. (Ollier.) A T-shaped incision is made. The horizontal incision corresponds to the crest of the ilium. A second horizontal incision is made about 2 to 3 cm. (0.8 to 1.2 inches) below the margin of the greatest sciatic notch. The vertical incision connecting the two corresponds to the size of the abscess and the position of the sinuses. The muscles attached to the posterosuperior spine are divided transversely, as are also the soft parts along the posterior portion of the ilium. These are then pushed forward. The lower transverse incision should avoid the gluteal artery. The periosteum is then lifted off from the inner side of the ilium, a chain-saw passed around, and the bone resected. A strong hook is inserted into the fragment next to the sacrum and traction made so as to dislocate this after separating the periosteum and the soft parts from the inner surface of the joint. After removing this fragment the articular surface of the sacrum is chiselled off, care being taken to spare the nerves leaving the sacral foramina.

4. Resection of one-half of the pelvis after Rieder in extensive tuberculosis of the sacroiliac joint. The incision commences at the anteroinferior spine and passes upward along the crest of the ilium

to the posterosuperior spine, and if necessary down to the apex of the coccyx. The abdominal muscles and the fascia are separated close to the bone and the entire mass of soft tissue, and pulled forward so that the inner surface of the squamous portion of the ilium is reached. In the posterior half of the incision one should hug the bone and divide the gluteal fascia and the fibres of insertion of the gluteus magnus and medius in such a way that the insertion of the external oblique and internal oblique in the posterior portion, as well as the lumbar fascia and the latissimus dorsi, remain adherent to the crest. After retracting the gluteal muscles downward the diseased bone may be resected with a chisel. The gluteal artery must be tied. This operation is so extensive that it is extremely dangerous in the weak individuals that usually are obliged to undergo this ordeal. Rieder divides the operation into two steps. Naz has collected 38 cases, which seem to show that the results of the operation are favorable, although sinuses remain in many of the cases. Some of the patients, however, succumb sooner or later to tuberculosis of the lung or intestine. Patients with evidence of tuberculosis in these regions and those with pronounced œdema should not be operated upon. Naz recommends early operation, and believes that certain of the cases that Sayre claims to have treated with conservative measures were not tuberculosis. The author cannot agree entirely with this opinion.

Syphilis of the Pelvic Bones.—Syphilis of the pelvic bones is extremely uncommon. The diagnosis will not be difficult when the early forms of periostitis or osteoperiostitis appear, because there will always be evidence of recent syphilis elsewhere in the body. The diagnosis of tertiary disease may be more difficult. The lesions may involve the ilium or the sacrum, and appear as a simple thickening of the bone or as caries with abscesses. The crest of the ilium is the favorite seat of the disease when this bone is involved. Circumscribed flat rounded swellings develop, or the crest of the ilium is thickened throughout.

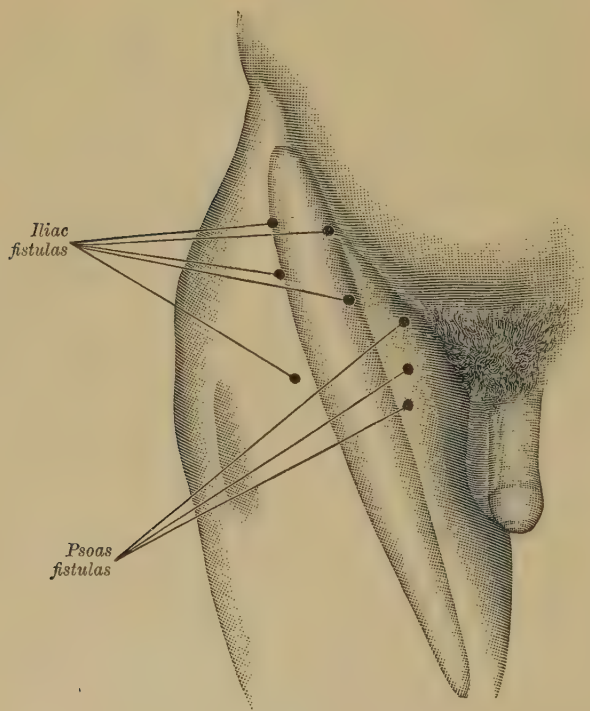
Treatment.—Broken-down gummata should be curetted and the necrotic bone removed with a chisel. Constitutional treatment is also indicated.

PELVIC SUPPURATION.

All of the diseases above mentioned may produce suppuration in the pelvis. There are other conditions that produce pus in this region, and pus may find its way into the pelvis from surrounding portions of the body. In many cases the position of the pus or the sinuses will indicate whether the pus is derived from the bones of the pelvis, from the vertebral column, or from the pelvic organs. The pus as a rule follows four routes. First of all, the iliac muscle and its sheath serve as a guide for the pus. These abscesses have therefore been called iliac abscesses, although the pus does not develop in the muscle itself, but in the sacroiliac joint, in the squamous portion of the

ilium, or in the acetabulum. The pus burrows downward, covered by the fascia either in or below the iliac muscle, and finally reaches Poupart's ligament. In very rare cases it may rupture the skin on a level with the iliopectineal eminence. Ordinarily, however, it passes beneath the ligament into the space between the outer margin of the iliac muscle and the inner margin of the rectus femoris. It may rupture here or wander still farther downward and appear between the rectus femoris and the tensor, or at the side of the sartorius. This muscle forms a guide, and the inner or outer margin indicates the

Fig. 18.



Seat of fistula openings.

lines in which the openings in the skin are apt to be found. These sinuses indicate more or less the bony origin of the process. Unfortunately the pus may break into the hip-joint by way of the bursa that is situated between the prominent portion of the capsule and the iliopsoas muscle. The hip-joint may in this way become secondarily involved. A second route is to have the pus appear in the sciatic foramen beneath the gluteal muscle, and rupture immediately or follow the flexors of the leg down the thigh for a varying distance. In other cases the pus follows the anterior surface of the sacrum down-

ward and appears in the perineum or in the ischiorectal fossa, or ruptures into the rectum. Finally the pus may take an upward course and rupture in the lumbar region at the outer margin of the quadratus lumborum.

In spite of the variation in position of the sinuses, abscesses of the pelvis have in common that they lie immediately upon the squamous portion of the ilium and may be seen or felt distinctly. These abscesses differ in this respect from the psoas abscesses and the subserous abscesses. Psoas abscesses are deeper seated than subserous abscesses, and are not so intimately related to the wall of the pelvis as the iliac abscesses. Psoas abscesses with few exceptions are chronic conditions in which the muscle acts as a guide to the pus formed in the vertebral column, just as the iliac muscle guides the pus of the pelvic girdle. The sinuses due to psoas abscesses are found along the inner side of the psoas muscle. Another peculiarity is the slight rotation of the thigh outward and flexion, which enable the patient to relax the inflamed muscle. These abscesses may also involve the hip-joint, and are far more liable to do so than the iliac variety. When they are under considerable pressure they may extend into the lumbar region and appear along the margin of the quadratus lumborum. They may also appear in the sciatic foramen beneath the gluteal muscles, as did the iliac abscesses.

The subserous abscesses develop from the viscera that are in part covered by peritoneum, such as the female genital organs, the cæcum, and the bladder. They rarely reach the squamous portion of the ilium, and usually appear superficially in the region of the inner two-thirds of Poupart's ligament, where they push the peritoneum upward. If they rupture externally, the sinuses are found immediately above or below the ligament. In the latter case they are apt to appear in the saphenous opening. Most suppurative processes in the iliac fossa developing between the fascia and peritoneum arise from the cæcum or the appendix. Traumatic conditions and puerperal infections are also of importance in this connection. The onset may be very insidious, although as a rule the symptoms appear suddenly, pain and intestinal disturbance being most common. It may be possible in the early stages to detect a more or less resistant region in the iliac fossa. This gradually extends toward the parietes, and fluctuation may be found. This inflammatory thickening does not always suppurate, for quite large firm masses that cannot be considered malignant on account of their insidious course have been known to disappear entirely and leave nothing but a small circumscribed indurated area. Compared with inflammation within the peritoneum itself arising from the appendix or from the uterine annexes, inflammation of the extraperitoneal region is insignificant from the first. These suppurative processes are distinguished from psoas abscesses by the absence of psoas contraction. König called attention to the progressing inflammation of the loose connective tissue of the cord. This sometimes

develops in connection with chronic suppurating processes of the epididymis, and has repeatedly been observed after amputation of the testicle. The inflammation extends through the inguinal canal into the pelvis, and from there into the region between the bladder and rectum as far down as the perineum.

It is evident how important it is to examine the pelvic viscera, the pelvic girdle, the hip-joint, and the column when any of the above abscesses are present, so as to avoid erroneous conclusions. Iliac and psoas abscesses are frequently associated, and need not cause a faulty diagnosis if the examination be careful. The conditions are much more simple when the pus arises from the external surface of the ilium, or from the posterior surface of the sacrum, provided there is no reason to suppose that the pus has extended outward into the gluteal region through the sacrosciatic foramen.

One should always consider the possibility that an abscess in the gluteal region may be primary of the soft parts. Abscesses of this sort may follow a fall and be secondary to a hæmatoma without being connected in any way with the bone. Recovery may be complete. These abscesses may also appear spontaneously, in children as well as adults.

Psoas abscesses may also be primary. Volkmann called attention to the fact that cases have occurred after some trauma or stretching of the muscle-fibres. Aside from the puerperal cases, König considers that primary suppuration of the psoas muscle is possible, and Steffen has recently collected certain cases in which the suppuration was undoubtedly primary in the psoas and iliacus muscles. The origin was unknown, although in certain cases there was a history of trauma. The statistics on this subject are to be found in French literature.

The abscesses developing rather rapidly in the retroperitoneal glands even after insignificant injuries to the corresponding leg belong also to this section. They may completely fill the iliac fossa. They are not uncommon in children, and if they involve the psoas muscle they may be followed by flexion of the hip-joint resembling that of hip disease. If the iliacus becomes involved, it may be supposed that the suppuration is due to some primary focus in the bone.

Treatment.—Opening of abscesses above Poupart's ligament should be done with considerable caution even though the peritoneum is pushed up. It is much safer to divide the structures layer by layer, just as in operating upon the external iliac artery. The incision should not be too small and drainage should be good. If the pus has reached the true pelvis, whether it comes from a bone or from the soft parts, simple incision will not be sufficient in many cases, and when the drainage is not adequate the pelvis should be trephined. The region attacked is behind the acetabulum, just above the inferoposterior spine. This portion of the bone is exposed by an incision 6 cm. (2.4 inches) long running straight backward from the upper portion of the great tro-

chanter. A drainage-tube is inserted and left in place until the abscess cavity has become well filled with granulations.

ANEURISMS OF THE PELVIC ARTERIES.

Inguinal Aneurisms.—There are only a few cases in which the aneurism was due to some primary trauma of the arterial wall. Aside from the case reported by Stevenson and Michael, which was an arteriovenous aneurism of the common iliac artery and vein, there is a case reported by Trendelenburg. An iron splinter punctured the right inguinal region of a blacksmith. Within six days a pulsating tumor the size of a goose egg developed beneath the ligament. The external iliac artery and femoral artery were tied. The femoral vein was left intact. The femoral artery had a hole in its anterior wall about 1.6 mm. ($\frac{1}{10}$ inch) in diameter which connected with the sacculated aneurism. Complete recovery. One reason why these tumors are so uncommon is that the injured individuals usually bleed to death before aid can be had.

Spontaneous aneurisms usually develop as the result of arteriosclerosis at a time when no changes can be palpated in the vessel-wall —*i. e.*, before forty years of life as a rule. The microscopical changes in the arterial wall in the early stages of this condition may be acted upon by some outside influence, such as a crush or a blow, and allow gradual distention of the region to occur. These aneurisms are traumatic in a certain sense, although the arteriosclerosis is really the primary cause and the trauma the secondary.

Mycotic emboli may cause an inguinal aneurism, as shown by the case reported by Bucquoy. There had been some previous puerperal disease of the heart, and the conditions present counterindicated extensive interference. A watch-spring was introduced into the aneurism after the manner recommended by Bacelli, with the desired result. Eight months later the patient died of cerebral embolism and the autopsy showed recovery from the aneurism.

Spontaneous aneurisms are by far the most common. Mitscherlich was able to collect but 13 cases up to 1890, and during the last six years only 7 further observations have been reported. The tumors pulsate, have a distinct thrill, and may be the size of a hen's egg. Buchanan's case reached from the apex of Scarpa's triangle up to the anterosuperior spine. After developing to a certain size the mass is subdivided by the ligament in such a way that the portion above belongs to the external iliac and the portion below to the femoral artery. The origins of the epigastric artery and circumflex iliac artery are frequently found in the sac, and it may be difficult in some cases to tell which vessel was primarily affected. If there is no pulsation and no thrill, a wrong diagnosis may be made. Verneuil reports a case in Lisfranc's clinic in which a hard large tumor was found in the groin and iliac fossa. This was considered to be an osteosarcoma of

the pelvic bone. This mass ruptured spontaneously and many clots were discharged. The patient died, and the autopsy showed the tumor to be a large aneurism. Sands reports a similar case in which careful examination showed that the mass pulsated. When the external iliac artery was compressed through the rectum the pulsation disappeared, a fact which enabled a correct diagnosis, because osteosarcomata of the pelvis, although extremely vascular at times, do not cease to pulsate when this vessel is compressed in the above manner.

Norris collected 4 cases in which the wall of the sac and the overlying skin had become inflamed. The mass was supposed to be an abscess, and was therefore incised with fatal result in all the cases. Certain of the iliac aneurisms are found entirely within the pelvis. Scriba reports a case in which an oval, irregular tumor the size of a fist was found in the right iliac fossa. The lower end of this seemed intimately connected with the external iliac artery. The tumor itself pulsated and had a distinct thrill. The common iliac artery was tied and the patient recovered completely. This vessel was chosen because on operation it was found that the condition had also involved the internal iliac. Putiatycki reports an interesting case from Langenbeck's clinic in which an inguinal aneurism of the left side eroded the horizontal ramus of the pubes and the hip-joint.

Of the bloodless methods of treating inguinal aneurisms, only indirect digital compression will be mentioned. When the size of the abscess or the overlying skin permits, this method should be tried first, for prognostic reasons, because it may show whether large branches are given off from the sac, which might interfere with the success of Hunter's ligature. Certain cases have been cured by indirect digital pressure. A case of this sort was reported by Treves, and is of especial interest because this indirect pressure was combined with direct compression of the aneurism, a method which has been justly abandoned ordinarily.

Treves followed Cooper's suggestion and compressed the external iliac artery sixty-six hours. He noticed then that the pulsation could be easily overcome by slight pressure upon the tumor, and introduced direct compression with weights. After ten days the tumor had become hard and small.

Digital compression should be abandoned if the success is not immediate, so as not to lose valuable time and leave the patient worse off than in the beginning. A ligature may be applied, as recommended by Hunter, to the external iliac artery above the aneurismal sac, and when this is extensively involved or the hypogastric artery is included, the common iliac artery may be ligated.

With aneurisms found pretty well up, it is best to tie the common iliac. Kümmell calls attention to the fact that after ligation of the external iliac for aneurism, gangrene of the leg was the cause of death in 11 of 26 fatal cases. Gangrene was the cause of death only 3 times out of 22 fatal cases in which the common iliac was tied

for the same reason. Rabe collected 83 cases of ligation of the external iliac for spontaneous aneurisms and mentions 5 cases of gangrene. Delbet mentions 21 operations upon the external iliac and no case of gangrene. Mitscherlich mentions 13 cases with no case of gangrene. This proves sufficiently that in spontaneous inguinal aneurisms that are to be treated by Hunter's ligature, it is best to tie the external iliac instead of the common iliac. When the profunda femoris opens into the aneurismal sac, the operation is just as unsuccessful as similar operations for the purpose of checking hemorrhage, and in these cases it is justifiable to tie the common iliac or excise the sac. Very few cases have been reported in which pulsation returned after the operation and the aneurism again increased in size. If this takes place, the aneurism should be excised just as any foreign growth, as recommended by Antyllus. The first operation of this sort was successfully done by Annandale and Hutchinson. Trendelenburg has successfully excised a traumatic aneurism, as already mentioned. Excision is especially justified in traumatic cases because collateral circulation does not develop well in tissues that are filled with coagula.

The rare cases in which the treatment should be that recommended by Bacelli have been already considered.

When pulsation disappears in an aneurism after Hunter's ligature has been applied, it is well to open the sac and press out the clot, provided it does not show any tendency to diminish in size and exerts pressure upon neighboring structures. The wound should be closed again immediately and a pressure-bandage applied. (Mikulicz and Körte.)

The treatment of spontaneous inguinal aneurisms is then as follows: first, indirect digital pressure; then Hunter's ligature, operation of Antyllus, or excision of the aneurism; and for the rare traumatic or ruptured aneurisms, excision or operation of Antyllus, and Hunter's ligature if necessary, with subsequent emptying of the sac?

Gluteal Aneurisms.—These are either spontaneous or traumatic. The vast majority develop from the gluteal artery, some from the sciatic artery, and very few from the pudic artery. There is oftentimes justifiable doubt as to which one of these vessels is involved. It is more correct, as suggested by Holmes, to consider the so-called diffuse traumatic aneurisms subcutaneous hemorrhages following stab-wounds in the gluteal region, and to call those accumulations of blood traumatic aneurisms that have a distinct sac. These circumscribed traumatic aneurisms are somewhat more common than the diffuse variety, and are ordinarily about the size of a hen's egg or even as large as a child's head, and may fill up the entire space between the sacrum, the ischium, and the great trochanter. Spontaneous aneurisms develop as slightly rounded tumors and grow very slowly, producing sciatic pain by pressing upon nerves. Gluteal aneurisms arise, of course, generally speaking, from the same causes that produce inguinal aneurisms,

although injuries play a much greater part. Fischer collected 35 cases of aneurism, 14 of which were considered to be traumatic. Several of the latter, however, were diffuse traumatic aneurisms, and of the 21 spontaneous aneurisms 9 gave a history of a blow followed by a slowly developing tumor which suddenly increased in size. The history after stab-wounds of the buttock is characteristic: there is marked hemorrhage, which is checked by pressure or suture, and several weeks later a tumor develops in this region.

Diagnosis.—The diagnosis of gluteal aneurisms is based largely upon the presence of pulsation and thrill. If these symptoms are absent, or the overlying muscles make the swelling appear to fluctuate, or the soft parts are inflamed, even the most expert surgeon has been known to make mistakes in diagnosis. Fischer mentions several examples which show that one should always think of aneurisms in connection with any swelling in the gluteal region that appears after some trauma.

One should be careful not to confound the condition with abscesses, especially if the patient appears for examination several days after the injury took place; and when there is some infection of the wound. Soft osteosarcoma may be associated with pulsation and murmur, and diminish in size on pressure, but the varying consistence of the tumor, showing alternating hard and soft regions, will enable a correct diagnosis. Some areas may almost fluctuate, others are hard. There may be egg-shell crackling and a lobular or nodular appearance of the tumor with enlarged glands in the vicinity, together with a run-down general condition, which is all in favor of a malignant tumor. Sometimes exploratory puncture will give the desired information, and should in any case be done before the region is incised. Cysts overlying the artery or sciatic hernia may also be of importance diagnostically.

After determining that the tumor is an aneurism, it may be difficult to decide whether it has arisen from the gluteal artery or from the sciatic artery. Aneurisms from the gluteal artery are usually found near the upper margin of the sciatic notch, while those of the sciatic artery are more liable to occur lower down near the tuberosity of the ischium. These differential points apply only to smaller aneurisms, for when the condition is of any size it is almost impossible to determine which artery is affected. In both varieties a portion of the sac may reach into the pelvis, especially if the condition has developed spontaneously.

Treatment.—Gluteal aneurisms always demand some form of treatment, because as yet Bouisson's case is the only one reported in which the condition healed spontaneously, as shown by autopsy. Sappey's case had an aneurism that remained the size of a walnut for about ten years, and then increased to the size of a hen's egg, and retained these dimensions for about ten years longer. If untreated, the sac bursts sooner or later and the patient bleeds to death. The choice of treatment is between Hunter's ligation of the internal iliac, liga-

tion of the gluteal or sciatic arteries after leaving the pelvis, opening the sac, as recommended by Antyllus, and ligation of all vessels opening into the same, and injection of ferric chloride into the sac. This latter method of treatment should be tried first with spontaneous aneurisms, because it is comparatively simple and the amount of risk is slight. Fischer describes the method as follows : A general anæsthetic is unnecessary because the operation is simple and painless, and when done with necessary precaution has never produced any disagreeable symptoms except in one case. The patients were allowed to get up between the fifth and the eighth day if necessary, and frequently were discharged after fourteen days. This injection treatment is applicable to all aneurisms of the gluteal and sciatic arteries, but not in cases of popliteal aneurisms, where there is danger of gangrene of the lower extremity. It has been used successfully in varicose, spontaneous, arterial, and anastomotic aneurisms. The chances of cure are quite good, and the death-rate is low. If there are no urgent symptoms, one should not hasten with the second injection, because the sac may become obliterated spontaneously, even after years, and may remain stationary for from two and a half to eight years.

The tumor is compressed laterally by an assistant, and about 3 to 4 grammes of a 20 per cent. ferric chloride solution are injected with a subcutaneous syringe. The seat of puncture is carefully closed with adhesive plaster.

When this method of treatment has proved useless, an open operation may be resorted to. Ligation of the gluteal or sciatic arches is not indicated in spontaneous aneurisms, because most of these extend into the pelvis, or the supply vessel is itself diseased. One should ligate the internal iliac, because the results are far better than formerly. If the iliac artery is diseased, as in the case operated upon by Büngner, then the common iliac must be tied. This case did not recover. In circumscribed traumatic aneurisms, Antyllus' operation is the most rational method of procedure.

NEW GROWTHS OF THE PELVIS.

Only those new growths that arise from the bones of the pelvis or from the soft parts will be considered. Both the bones of the pelvis and the soft parts are liable to be affected by homogeneous or heterogeneous growths, the character of the tumor at times being indicated by its location. The tumors may therefore be subdivided into those arising from the soft parts outside of the pelvic girdle, those of the bony pelvis itself, and those developing from the connective tissue within the pelvis. The congenital tumors of the sacrum and coccyx have already been considered.

The tumors developing in the soft parts are found almost exclusively in the gluteal region. They are either cystic or solid. The cysts may be sebaceous cysts or dermoids, and the solid tumors may be lipoma,

myxoma, or sarcoma. König has reported a case of primary carcinoma of the gluteal muscles in a young woman. The tumor developed close to the sacrum, and this author considers that the origin is to be explained by some epithelial nucleus having become displaced. Lipomata in the gluteal region do not present any special characteristics. They may be pedunculated, non-pedunculated, and vary considerably in size. Myxomata are found especially in the region of the sciatic foramen, and are liable to extend inward into the pelvis. They may become adherent to the sacrum, or appear as myxoma lipomatodes. (Lücke.) Sarcomata are rather uncommon, and are apt to be of the more benign variety, and when they are not too large the prognosis after their removal is comparatively favorable. Cysts developing from the bursa in the vicinity of the tuberosity of the ischium are extremely uncommon (Roser, König, Büngner), because this bursa is not at all constant, and the region is well protected by the thick overlying soft parts from outside influences.

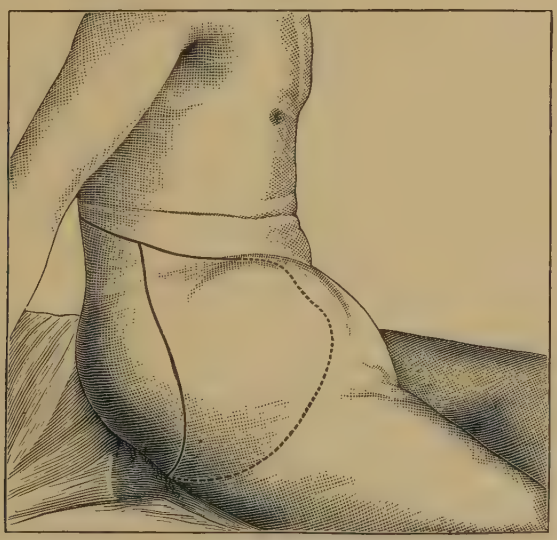
Sebaceous cysts are most common, and develop between the tuberosity of the ischium and the anus and may become of considerable size. Dermoids are next in frequency, and develop either exactly in the median line or close to it in the region of the last three sacral vertebræ or over the coccyx. These tumors never become much larger than a date and are rarely noticed by the patient.

When the tumor becomes inflamed for some reason or other, the patient notices a painful swelling in the intergluteal fold. These cardinal signs increase, and may disappear under appropriate treatment, or the tumor may suppurate and leave a permanent sinus which may be mistaken for all sorts of conditions. One will be able to make a differential diagnosis if the fistula is found exactly in the median line and leads to one or two small pockets the result of faulty inversion of the epithelium. Not infrequently one will be able to find hair with the naked eye, and microscopical examination of the pus will show fatty degenerated epithelium and fine hairs. These dermoid cysts are congenital beyond doubt, and correspond to the congenital depressions and sinuses in the region of the sacrum that have been extensively investigated by French authors. (Walther.)

The tumors that develop from the bones of the pelvis are liable to be exostoses, enchondromata, fibromata, and sarcomata. All of these conditions are rare, but the sarcomata are most frequently observed. Fibromata and exostoses are absolutely benign, and so are enchondromata in the early stages. Later they may extend to the neighboring soft parts and independent metastases may develop here. When an enchondroma erodes one of the large pelvic veins, metastases may appear in distant organs. Weber recognized the importance of emboli for the development of metastatic cartilaginous tumors in connection with an enchondroma of the pelvis. These tumors of the bones of the pelvis usually have a definite seat corresponding to their histological peculiarities. Fibromata are more liable to occur along the anterosuperior

spine and develop from here downward. They are usually single and arise from the external connective-tissue layer of the periosteum. They have a smooth surface and are of very dense consistence, or may be very succulent and resemble deep fluctuating conditions. They sometimes become ossified or calcified, and undergo all of the changes that fibromata are liable to suffer. The soft variety has a tendency to recur locally, and is really the intervening condition between fibroma proper and sarcoma. Females seem to be more often affected, especially during the middle years of life. In this respect these tumors correspond to fibromata of the abdominal parietes, and the fact that they may extend inward between the parietes and be connected with their primary seat of origin only by means of a thin pedicle, is probably the reason why the two conditions have been confounded. (König.)

Fig. 19.



Periosteal sarcoma starting in centre of the innominate bone and extending from the acetabulum and ligamentum teres to the head of the femur. (Lines show incisions.) (Salisteschef.)

Exostoses and enchondromata are more liable to occur in the region of the sacroiliac synchondrosis. The exostoses may be single or multiple. It would seem that all of the exostoses observed in the region of the pelvis are cartilaginous exostoses in Virchow's sense of the word, because they are always covered, at least the knobs, by a thin layer of cartilage. It may be that these exostoses and enchondromata are intimately related, not only on account of the above facts, but because they are liable to occupy the same position in the pelvis. It is not impossible that the tumors are primarily cartilaginous, and that in one case they become bony and in another they develop cartilage. In the cases of multiple cartilaginous exostoses other portions of the

skeleton are afflicted in the same way. The normal shape of the pelvis may sometimes be influenced by the seat of these growths as well as by their size and number. In women this may produce considerable trouble during childbirth, and it is always best to examine the pelvis of girls very carefully when they show exostoses in other regions of the body. (Dessel, Hagen.) Individual exostoses may develop to considerable size and produce all sorts of disturbances. Braunstein has collected several very interesting observations of this sort, and Kramer has recently removed an exostosis the size of man's fist that was attached by a broad base to the posterior surface of the horizontal ramus of the pubes and to the upper portion of the descending ramus.

Exostoses produce symptoms only on account of their size. When they are situated externally in the anterior region of the pelvic ring, they may interfere somewhat with walking or give rise to neuralgia on account of pressure upon the obturator nerve. When they are situated within the pelvis, their size may interfere with the normal function of the pelvic viscera. On palpation they present a smooth, uniform character, sometimes covered with small knobs, and just as the enchondromata, they have been subdivided into internal and external exostoses, depending on whether they are found within the pelvis or on the outer surface. Internal enchondromata are always found on the ilium close to the sacroiliac joint (Bergmann, Pfeifer), whereas the external enchondromata are always supposed to appear on the rami of the pubes or ischium. This is not always the case, because Havage reports a case of enchondroma of the sacrum, and Riesmann has recently reported a case of enchondroma that appeared on the anterior and inner walls of the pelvis. It is of importance from an operative standpoint to know that the enchondromata are peripheral tumors that are connected with the underlying tissue by a peduncle of varying size. Both the internal and external enchondromata of the pelvis develop without producing symptoms. Later the external variety may put the skin under such tension that it becomes ulcerated. There is occasionally a tendency to form metastases which may not appear until quite late. Sometimes these tumors become a nuisance to the bearer on account of their size. They are apt to be the largest of all pelvic tumors, and are at first of uniform consistence. Later, areas of softening appear which at times may seem to fluctuate. The knob-like surface and budding nature of the growth are more or less characteristic.

Besides the three varieties of neoplasms above described, surgeons have to deal with sarcomata, which are much more common, besides being malignant. These may be periosteal or outside of the bone entirely, or they may develop from the marrow of the bones. The periosteal tumors are liable to be mixed growths, such as fibro-osteosarcoma or chondro-osteosarcoma, and are not quite so malignant. Sarcoma develops from the internal layer of the periosteum, while the outer layer may remain intact as a fibrous covering for a considerable length of time. The sarcomata developing from the marrow are apt to be very vascular and

pulsate. When they appear on the outer surface of the ilium there is little difficulty in recognizing the nature of the disease, but when they occur in the interior they have been confounded with aneurisms. Both sexes are about equally affected, usually between the thirtieth and the sixtieth year of life, although sarcomata have been reported in infants and children and in senile individuals. In most of the cases sarcoma of the pelvic bones is primary, for only in a few cases has a sarcoma of the pelvic organs been known to extend to the bones. These pelvic sarcomata are very liable to involve the neighboring tissues, and they extend from one bone to another very readily. The middle portion of the iliac fossa—*i. e.*, the region outside of the nerves and vessels—is the region most frequently involved. The neighborhood of the sacro-iliac joint, the sacrum, or the pubes, are rarely the primary seat of the growth. These tumors are closely united to the bone, and there is no sharp line of demarcation, although they as a rule shell very readily.

The surface of a sarcoma is smooth or only slightly lobulated, without any deep furrows as found in enchondromata. The neoplasm varies in consistence in different places. It is sometimes tense, sometimes almost fluctuating, and occasionally there is egg-shell crackling. As a rule the skin is not changed, but when the growth increases rapidly in size the cuticle may become thin and ulcerated. In these cases the muscles lying between the skin and the growth itself may show secondary nodules. Sarcomata of the iliac fossa soon press upon the nerves. It will then be possible to palpate the growth, and later there will be œdema of the legs due to pressure upon the vessels. Pain is the first symptom. These patients complain of persistent rheumatic pain in the leg and loin, or in the hip and knee. This pain usually appears when walking or standing up, or with any exertion, and disappears on lying down. The condition may be confounded with sciatica or inflammation of the hip-joint. It is remarkable that in many cases the patients complain that the pain appeared suddenly, a fact which distinguishes sarcoma of the pelvis from the benign growths. The pain increases with the size of the tumor and may become unbearable. The general condition soon suffers and the patients are apt to die within a short time after symptoms produced by pressure upon the pelvic organs and general cachexia appear. Strange to say, there is in certain cases an irregular temperature without any necrosis or infection in the growth. The clinical picture depends upon the rapidity with which the tumor develops, and this again depends upon the abundance of the cells. Metastases in distant organs, such as the lungs, hasten the end-result, of course.

Carcinomata occur as metastases in the pelvic bones, and certain carcinomata of the breast are very liable to form metastases in the sacrum. In the following pages will be considered the tumors that develop from the connective tissue of the pelvis, such as the echinococcus cysts. Sebaceous cysts are also supposed to occur in the connective tissue of the pelvis (König), although there is some doubt whether

these are not the same as certain dermoid cysts described by Sänger. They are found inside of the pelvic diaphragm immediately beneath the peritoneum, and usually in the left side of the pelvis. They have but one cavity with a thin wall, and appear after puberty or still later, and differ in this respect from the other cysts and teratomata of the sacral region. The rectum and vagina are always displaced to the right, and are stretched out as a thin covering over the growth. These tumors develop downward toward the perineum and finally displace the perineum, the anus, and the ischiorectal region considerably.

In certain cases it is possible to give the cause of these new growths. The exostoses and enchondromata are undoubtedly congenital, and in cartilaginous exostoses heredity seems to be of some importance. Some disturbance of growth in the region of the pelvis has been supposed by Virchow and Riesmann to be responsible for the enchondromata. Trauma can, of course, not be eliminated in these tumors, and may be an etiological factor at times in sarcoma. Some of the older communications (Billroth) mention that the patients claim that the tumors developed after some injury, such as a blow or fall, and recently similar observations have also been reported: Soldier, twenty-three years of age, December, 1880, fell on his buttocks. February, 1881, showed pain on passing urine, which was otherwise normal. Later he passed urine and feces involuntarily. In May he began to wander mentally and had pain in his leg, with diminution of the motor power of the right leg. A growth could be detected within the pelvis, which increased rapidly in size and early in June produced paralysis of the right perineal nerve. Toward the end of June hallucinations. Died July, 1881. The autopsy showed a large spindle-cell sarcoma that had eroded the sacrum and both flanges of the ilia. (Löwenthal.) Similar cases have been reported by Ziegler, Kaufmann, and Tegeler.

The cysts developing over the tuberosities of the ischium also bear some relation to previous injury. They are found most frequently in people who are obliged to sit a great deal while doing hard manual labor.

Those neoplasms found outside of the pelvis are, of course, much easier to recognize than those on the inner side of the pelvis, because the number of conditions to be considered is much smaller, and all of the new growths and inflammations connected with the pelvic organs of women can be excluded. With the internal variety and connective-tissue growths one is obliged to eliminate disease of these organs by careful bimanual examination. If there is a swelling in the gluteal region that fluctuates, this condition can only be one of the above-mentioned cysts, an abscess, or an aneurism, provided a congenital tumor can be excluded. Echinococcus cysts are very apt to appear in the sciatic foramen, having developed first in the true pelvis. Pelvic abscesses follow the same course, and gluteal aneurisms and sciatic hernias are also found in this region. Abscesses are frequently associated with fever, and careful examination of the

pelvic bones will usually detect some focus of inflammation. Aneurisms pulsate, or have a murmur, or present the symptoms already mentioned in connection with gluteal aneurisms. One should always consider whether the patient comes from a region where echinococcus is prevalent. It may be possible to make a diagnosis without any exploratory puncture, although this should always be done in doubtful cases. With other cystic tumors the peculiarities above described, especially the seat of the growth, should be taken into consideration. When the cysts are very tense and deep-seated they may be confounded with a solid tumor; for instance, a myxoma in the region of the sciatic foramen.

The diagnosis of external lipomata and periosteal sarcomata is comparatively simple. The latter are but slightly lobulated and of uniform consistence compared with the non-pedunculated lipomata. The myeloid sarcomata occurring on the external surface of the ilium may be recognized by their comparatively firm consistence, the pulsation, and the fact that the swelling merges gradually into the surrounding tissue. External exostoses and enchondromata are not difficult to recognize. This latter remark applies also to internal exostoses and enchondromata. The firm consistence, the nodular surface, the slow, painless development are absolutely characteristic signs of internal as well as external exostosis, and when discovered early can be confounded only with a callus or some rhachitic malformation of the pelvis. The nodular surface is not in favor of callus, and the evidence of rhachitis in other regions of the body will throw some light on the nature of the local condition.

It is not always possible to decide whether one has to deal with an exostosis or an enchondroma, for both conditions present the same symptoms when small. After having reached a considerable size an enchondroma is recognized by the abrupt nodular prominent portions, signs of softening, and rapid development of differences of consistence. A tumor developing rapidly and presenting these characteristics is not an exostosis, but an enchondroma.

The seat of the growth is also of more or less importance, for, generally speaking, the external exostoses and enchondromata are found in the anterior region of the pelvic girdle, while the internal exostoses and enchondromata are more liable to occur in the region of the ilium close to the sacroiliac joint. A tumor with a smooth surface, of firm consistence, and without producing any pain, slowly developing in the region of the anterosuperior spine, is probably always a fibroma.

The sarcomata developing in the interior of the pelvis are characterized, as compared with the exostoses, enchondromata, and fibromata, by being extremely painful at a time when it is impossible to detect the growth on examination. Later their slightly lobulated surface, soft consistence, and extension to the neighboring regions will indicate their true nature. Certain sarcomata are characterized by egg-shell crackling or pulsation. The latter symptom, however, is frequently the reason why they are confounded with aneurisms. The seat of the

tumor is more or less characteristic of sarcomata. These develop usually in the iliac fossa, and are associated early with disturbance of the general condition. Besides aneurisms the differential diagnosis should consider inflammatory conditions of the iliac fossa. Sometimes an exploratory puncture alone will give the desired information. Tumors of the pelvic connective tissue occur in three forms: 1, those developing from the pelvic organs; 2, dermoid cysts; and 3, echinococcus cysts. The first class must be excluded in the manner already described. The dermoid cysts have been considered in connection with congenital tumors of the coccyx, and the echinococcus cysts are most readily detected by exploratory puncture. The firm consistence of the mass should not deter one from undertaking this step.

The prognosis of all these neoplasms depends not only on their histological structure, but also upon their location and the amount of disturbance that they produce. The cystic tumors are absolutely benign. Fatty growths and even periosteosarcoma on the outer surface of the pelvis can be readily removed. The prognosis of myxoma is more doubtful.

As far as the outlook in osseous tumors is concerned, exostoses are the most favorable, because they rarely produce symptoms, grow very slowly, and after the twenty-fifth year of life not infrequently remain stationary. The prognosis of fibromata is also favorable, because they are annoying only on account of their size. Enchondromata when small and in the early stages correspond to exostoses, but when they commence to grow rapidly they become dangerous not only on this account, but also because of their infectious character. Certain sarcomata are relatively harmless in the early stages, but in the later stages they are always extremely malignant.

The treatment is always operative. The sinuses of dermoid cysts should be opened with the cautery and the small epithelial pockets thoroughly destroyed. Intact dermoid cysts, sebaceous cysts, and serous cysts should be enucleated. This applies also to fatty tumors occurring in the soft parts outside of the bony pelvis. The operation should be very thorough in periosteal sarcomata, so as not to leave any remnants behind that might give rise to recurrence. Bergmann operated successfully upon an enchondroma of the left ilium. The internal exostoses should be removed only when they grow rapidly and produce considerable disturbance, and when they are sufficiently firm and localized, so that one may follow them up to their seat of origin. The encapsulated movable fibromata and sarcomata at the entrance of the pelvis may be reached by means of an incision corresponding to that used for ligation of the external iliac artery and may be shelled out by blunt dissection. Bergmann operated upon his case in this way, but was obliged to tie the common iliac artery and vein and chisel the thin peduncle from the wall of the pelvis. Heineke removed an enchondroma the size of a child's head from the anterior pelvic ring after resecting the horizontal ramus of the pubes. He was

obliged to curette a large portion of the new growth out of its capsule. Kramer removed an exostosis in a pregnant woman from the posterior surface of the pubes through the lower opening of the pelvis.

Czerny has removed a large part of the ilium for sarcoma, as has also Trendelenburg. Kocher and Roux made use of an incision recommended by Larghi for the purpose of operating upon osteomyelitis of the pelvis, and both of these surgeons have removed one entire half of the pelvis. Körte and Volkmann have resected the sacrum for myxosarcoma. Gussenbauer recommends that tumors of the pelvic bones should be removed if in any way possible. In spite of the hopeless outlook in sarcoma, one should operate when in any way possible, although it is best in this direction to follow the rule laid down by Bergmann.

ECHINOCOCCUS OF THE PELVIS.

In vicinities where echinococcus is common the pelvis is not infrequently involved. The cyst will be found immediately beneath the skin or in the muscles, and when beneath the latter it has usually extended from the small pelvis through the sciatic foramen. In these cases it will be possible to find a tumor within the true pelvis. This latter tumor will be the primary condition or it will be connected with some abdominal organ situated higher up. The parasite extends along the female pelvic connective tissue just as a parametritic exudate (Schatz), and in men it is more liable to become localized between the bladder and the rectum. When left to themselves, the cysts become of considerable size and may rupture into the bladder, the vagina, or into the rectum.

Fischer reports the case of a man twenty years of age who suffered from difficulty in urinating. A catheter met obstruction in the membranous portion and the urine was alkaline and clouded. In the right hypogastrium near the middle line a soft painful tumor about the size of an apple could be felt. By rectum a soft, smooth, tense tumor could be felt on the right side, and in the perineum at the right side of the anus there was a flat sensitive swelling about 5 cm. (2 inches) in diameter, which was aspirated and found to contain light transparent fluid.

Echinococcus may be primary in the pelvic bones. The number reported is very small, and some of these are so-called multilocular echinococcus cysts, such as the case described by Trendelenburg, although the histological description of these cases does not correspond to Virchow's multilocular echinococcus of the liver, because in all the pelvic cases there were cysts of varying size containing a scolex with hooklets. They correspond somewhat to Virchow's cysts in that they have a tendency to suppurate and extend in the bone by means of tab-like prolongations. One might therefore speak of large cyst and small cyst echinococcus of the pelvic bones, and Vierordt's

opinion seems justified when he considers that the occurrence of multilocular echinococcus of bones has not been proved in the strict sense of the word. Wilms has recently reported a case of echinococcus of the sacrum that had developed in the canal outside of the dura, and had subsequently involved the muscles in the lumbar region and in the left iliac fossa. Later the pubes and the region of the bladder became involved. Microscopical preparations showed that the growth took place in a tubular manner, a peculiarity which may depend perhaps on the structure of bone. According to this author's opinion, only very small cysts can develop in the bone itself, but as soon as the soft parts become involved larger cysts may develop.

Echinococcus of the pelvis is found chiefly in the region of the ilium and acetabulum. The cyst rarely becomes larger than a man's fist, although in exceptional cases it may be very extensive and involve an entire half of the pelvis. (Viertel.) The ischium and pubes are much more rarely involved. The hip-joint is almost always affected secondarily, and the clinical picture then resembles that of hip-joint inflammation very closely. In most cases hydatids are found in the connective tissue of the pelvis.

Symptoms.—The clinical picture is that of any pelvic cyst when the soft parts are involved. When the bone is involved, the condition may resemble suppuration of the pelvis or hip disease. Bardeleben reports a case in which a swelling existed for four months in the inguinal region, and when opened was found to contain pus. Later, while changing the dressing, a small cyst was found which proved to be echinococcus. A bony swelling could be felt in the region of the ilium, which was operated upon and found to be a cavity in the bone filled with echinococcus.

Prognosis.—The prognosis depends upon whether there is a localized focus in the soft parts or whether the pelvic bones are involved, or whether other organs are affected at the same time. Echinococcus of the external soft parts of the pelvis and of the connective tissue of the true pelvis is very amenable to operative interference. The prognosis of bony echinococcus is bad. With the exception of Bardeleben and König's cases and Brentano's case, in which the disease appeared as a large hard nodular swelling of the ilium, all the patients succumbed to the suppuration.

Treatment.—Echinococcus of the soft parts outside of the pelvis and of the intrapelvic connective tissue is best treated by simple incision, followed with antiseptic dressing. The sac usually separates off of its own accord. Schatz operated through the vaginal wall, and Ratimow was obliged to turn the sacrum back temporarily. Bony echinococcus cysts are not especially favorable objects for surgical interference, although one should always try to clean away the diseased portion of the bone with a curette or chisel.

CHAPTER IV.

PELVIC OPERATIONS.

LIGATION OF THE PELVIC ARTERIES.

Ligation of the Common Iliac.—This has been done intraperitoneally, although all extraperitoneal operations are the normal method of procedure, because if any of the neighboring vessels have to be tied, it is easier to do so after the peritoneum has been pushed back. In inguinal aneurisms, however, as shown by Sands' case, it may be impossible to reach the artery by the retroperitoneal route. The skin-incision for retroperitoneal ligation must be large, and commences in the region of the external ring 2 cm. (0.78 inch) above Poupart's ligament, and is carried upward and outward in a curved line to about the region of the anterosuperior spine. (Valentin, Mott.) The dissection is carried down layer by layer until the transverse fascia is reached. This should be divided upon a director throughout the entire length of the incision, and the peritoneum is then carefully stripped up as far as the promontory. If the ureter is not adherent to the peritoneum, it will be found running obliquely across the point of division of the iliac artery. This vessel is separated from the surrounding tissue by blunt dissection, care being taken not to injure the ureter or the spermatic vessels. The aneurism-needle is passed on the right side from without inward and on the left side from within outward, because of the position of the veins.

The common iliac is tied as a preliminary step in bloody operations in the region of the hip when operating upon very vascular tumors in this region, for aneurism, and in case of hemorrhage. When operating upon tumors, or when exarticulating at the hip-joint, preliminary ligation of the common iliac artery may not be sufficient to control the hemorrhage, and Trendelenburg reports a case in which there was considerable hemorrhage from the femoral vein, and recommended that the external iliac vein be tied also, so as to prevent hemorrhage from below. Bose operated successfully in this manner, although he tied the internal iliac at the same time, because after ligation of the common iliac the peripheral portion remained distended with blood. Schönborn exarticulated the hip after Trendelenburg's method, and reports that there was partial necrosis of the skin-flaps. He therefore considers that the common iliac should be tied only temporarily during the operation. This temporary occlusion is best done with a broad pair of clamps, the jaws of which are covered with rubber tubing.

When the corresponding leg is not to be amputated after ligation

of the common iliac artery, the collateral circulation must, of course, develop very quickly. Fig. 20 illustrates how this takes place, especially through the anastomosis between the sacralis media and the internal iliac of the opposite side. Besides this communication the anastomosis of the deep epigastric with the internal mammary, and of the circumflex iliac with the lumbar arteries, is of importance.

FIG. 20.

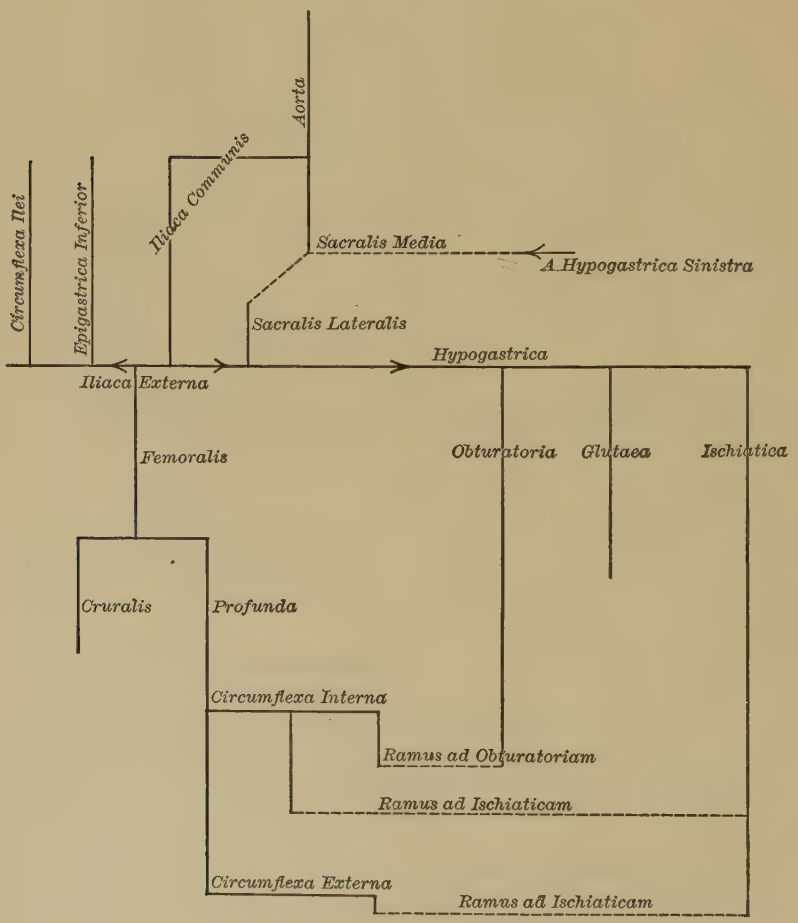


Diagram of pelvic arteries.

In hemorrhage from the femoral artery the collateral circulation is restored through the obturator artery and sciatic artery, and the internal and external circumflex branches of the profunda, provided the external iliac has been tied. This dangerous collateral circulation can only be controlled by tying the common iliac. When there is hemorrhage from the femoral artery, the vessel should be tied in the wound, includ-

ing all the lateral twigs, as recommended by Kocher, or, should this not be possible, the common iliac itself should be ligated.

Ligation of the External Iliac.—When done extraperitoneally, an incision 7 to 8 cm. (2.75 to 3.10 inches) is made 1 cm. (0.39 inch) above Poupart's ligament, commencing at the anterosuperior spine. (Abernethy.) The subsequent steps are the same as those taken for ligation of the common iliac, although it is much easier to expose the vessel, and the needle may be passed on both sides from within outward. The line of incision may divide the superficial and the deep epigastric, which may have to be tied in the wound. Of late years the external iliac has been repeatedly tied extraperitoneally. Banks, Marmaduke, Sheild, and Dennis each opened the peritoneal cavity in the right linea semilunaris for the purpose of operating upon an inguinal aneurism. The large and small intestines were retracted and the artery tied through the peritoneum. The wound healed by first intention. Stevenson, Michael, and Davie operated in a similar way for diffuse traumatic aneurisms and for spontaneous aneurisms of the external iliac. It would seem that intraperitoneal ligation is perfectly justifiable, therefore, in cases in which on account of the size of the aneurism there is insufficient room for operating extraperitoneally. Aside from this reason there seems to be no indication for operating other than extraperitoneally.

Ligation of the Internal Iliac.—This is done through the same incision as made for the common iliac artery. The operation itself, however, is somewhat difficult because of the vein and the ureter.

Ligation of the Superior Gluteal.—An incision 15 to 18 cm. (6 to 7 inches) long is made in the direction of the fibres of the glutæus maximus, starting from the posterosuperior spine and reaching down as far as the great trochanter. After separation of the muscle the pyriformis will be seen. It may be somewhat difficult to expose the artery because of the overlying plexus or vein, and the artery itself may divide within the pelvis.

Ligation of the Inferior Gluteal or Sciatic.—The skin-incision is made from the posteroinferior spine to about the base of the great trochanter, and after the glutæus maximus has been separated the lower margin of the pyriformis is sought for and the spine of the ischium and the sacrosciatic ligament are exposed. The artery will be found lying on the ligament. One should be careful not to injure the sciatic nerve.

Ligation of the Internal Pudic.—This is done through a similar incision, and the artery will be found more toward the median line as it crosses the spine of the ischium, with the internal pudic nerve lying to the inner side. The course of the vessel back into the pelvis will remove any possible doubt as to identity. This vessel has been ligated because of aneurism and injuries.

MALFORMATIONS INJURIES, AND DISEASES OF THE ANUS AND RECTUM.

CHAPTER V.

ANATOMY OF THE RECTUM—METHODS OF EXAMINATION OF THE RECTUM.

Diseases of the rectum are very common, and their proper treatment is a matter of great importance to the health and even the life of the patient; yet scientific treatment is often wanting, either because the patient trusts to some vaunted cure, or because he will not permit his medical adviser to make a thorough examination. At other times it is the physician who is at fault, contenting himself with the patient's description of his ills in place of obtaining by his own examination accurate knowledge of the lesion present. In no part of the body is a thorough examination more important. Such examination should invariably be made, not only when a patient complains of pain or other abnormal feeling in the rectum or about the anus, or of passage of mucus, pus, or blood, but also when there are such general symptoms as obstipation, diarrhœa, flatulence, pain in the sacral region, etc. In women, lesions of the rectum are often confounded with those of the genital organs. A conscientious surgeon will not begin treatment until he has made a diagnosis based on a careful examination of the affected parts.

Anatomy.—According to Waldeyer, the rectum extends from the anus to the promontory of the sacrum, and measures in the adult from 25 to 33 cm. (10 to 13 inches). The distance from promontory to anus in a straight line is 18 cm. (7 inches). The anus is situated 3 to 4 cm. (1.2 to 1.5 inches) from the point of the coccyx. For convenience the rectum is divided into two parts, the perineal part (pars perinealis recti), which is lined with stratified epithelium, and the rectum proper (pars pelvina recti), which is lined with cylindrical epithelium. The perineal part begins in the anus and extends forward and upward a distance of 2.5 to 3 cm. (1 to 1.2 inches) to the upper edge of the internal sphincter muscle. It is surrounded by the internal and external sphincter muscles, which are arranged in such a manner that the external muscle reaches about 1 cm. (0.39 inch) nearer the anus than the internal.

The lowest portion of the perineal part is lined with skin (zona

cutanea), which reaches to the lower border of the internal sphincter, and is separated from the next portion (zona intermedia) by the anocutaneous line. The intermediate zone measures 1.5 cm. (0.6 inch), and is lined with a mucous membrane having small papillæ and bearing stratified epithelium without a horny layer. Next above is the columnar zone, which is distinguished by eight or ten longitudinal folds in its mucous membrane (columnæ rectales s. Morgagni). These folds are more pronounced below. Above they fade away into the true rectum. Between their lower ends are little semilunar closed pockets called the rectal sinuses or the sinuses of Morgagni. The upper margin of the columnar zone is sometimes called the anorectal line. Above this line the stratified epithelium changes to cylindrical epithelium with crypts of Lieberkühn and the true or pelvic rectum begins.

The pelvic rectum begins at about the level of the lower border of the prostate gland, and extends upward and backward to the third sacral vertebra. It is closely shaped to the hollow of the sacrum. It is 10 to 12 cm. (4 to 5 inches) in length. Its lower portion has no peritoneal covering, but is surrounded by the connective tissue of the pelvis. The peritoneal reflection called Douglas's pouch is at the level of the fifth sacral or first coccygeal vertebra in man; in woman it is a little lower. Above this the rectum is covered by peritoneum in front; and higher up, the peritoneum extends also to the sides. Douglas's pouch is situated from 1 to 1.5 cm. (0.39 to 0.6 inch) above the upper margin of the prostate gland, or 5 to 6 cm. (2 to 2.3 inches) from the anus. The portion of the large intestine lying above the third sacral vertebra is surrounded by peritoneum and has a meson called the mesorectum. On this account it is now included in the term large intestine and designated the pelvic colon.

The lower half of the true rectum has a wide lumen in which fecal masses collect during the period between evacuations. The mucous membrane which lines it lies in transverse folds and bears a cylindrical epithelium, with crypts of Lieberkühn. The levator ani muscle is attached at the junction of the perineal and pelvic parts of the rectum, extending backward to the coccyx, and laterally to the arcus tendineus of the pelvic wall. In front it reaches the lower margin of the prostate gland. It thus forms a diaphragm separating the anus and perineum below, from the pelvic rectum above.

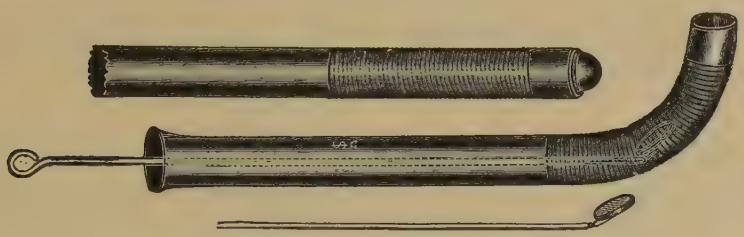
The fascial planes are spoken of in the section on Periproctitis, page 107; the bloodvessels in the section on Hemorrhoids, page 124, and the lymph-channels in the chapter on Carcinoma of the Rectum, page 151.

Method of Examination.—The first act in a systematic examination of the rectum is inspection. Four positions of the patient are possible. He may stand with his back to the window, and bend well forward, placing his hands on a chair; or he may lie on his side upon a table with the under thigh extended, the upper one sharply flexed; or he may lie upon his back with both thighs well flexed, or he may assume the knee-chest position. Each position has its advantages.

When the nates are drawn well apart, the anus and the skin about it and within it are brought into view. If the patient is directed to strain, and at the same time the finger of the surgeon wrapped in gauze smooths out the radial folds, a view is obtained well into the anal portion of the rectum. This manœuvre should be carried out with great gentleness, since spasm of the sphincter muscle will at once cut off a large part of the field of view.

Digital examination follows inspection. This is the most important part of a thorough examination, and usually leads to a diagnosis. The nail of the examining finger should be cut short so as not to wound the mucous membrane. There is some risk of infection when the bare finger is introduced into the rectum. Syphilis has many times been acquired in this manner. It is, moreover, extremely disagreeable to the surgeon to have the crevices about the nail so filled with feces that

FIG. 21.



Bodenhammer's rectocolonic speculum.

repeated washings of the finger fail to remove the bad odor. Hence it is advisable to draw over the examining finger a very thin rubber cot, several of which can readily be carried in the pocket-book. When this habit is formed, digital examination of the rectum will not be so sadly neglected as it is at present.

With the patient in any of the four positions mentioned, the lubricated finger is slowly introduced in the direction of the anal canal—that is, upward and forward. Additional knowledge of the condition of the rectum will be obtained if the fingers of the opposite hand press lightly on the surface near the anus, so that the parts can be felt bidigitally.

Above the narrow perineal portion the finger passes into the wide ampulla and feels the soft transverse folds of the mucous membrane of the pelvic rectum. If directed backward, it touches the posterior portion of the levator ani muscle, and the coccyx. In front the prostate gland is palpable, which rests upon the levator ani. Above the prostate is the base of the bladder, and above that, 1 cm. (0.39 inch) from the upper margin of the prostate, is the peritoneal reflection. Close above the prostate, and to either side, are placed the seminal vesicles, and still further laterally the ureters.

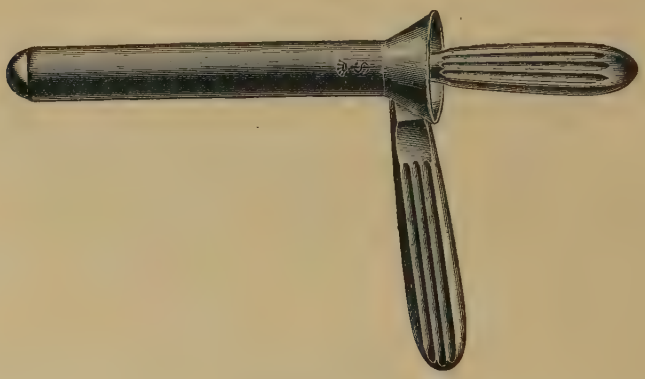
In woman a part of the anterior wall of the rectum may be in-

spected if it is pushed out of the anus by the finger introduced into the vagina. The finger in the rectum if directed anteriorly, feels above the anal portion, first the posterior wall of the vagina, then farther up the cervix uteri and Douglas's pouch.

In either sex considerable additional information can be obtained if the patient is anæsthetized, and one hand is placed on the abdomen so as to crowd the structures against the finger in the rectum. In children most of the abdominal contents can be palpated in this manner.

Finally, it is of advantage to examine the patient in an upright position, directing him to strain while the surgeon's finger is pushed well upward. By this means the pelvic organs will be pushed down against the finger, instead of drawing away from it as is the case when the pelvis is elevated above the chest.

FIG. 22.



Kelly's proctoscope.

Simon among others has advocated that the whole hand be introduced into the rectum. By this means the examination can be carried upward to the beginning of the sigmoid colon. Serious injury, such as rupture of a diseased rectum or the bursting of an abscess into the general peritoneal cavity, may follow this manipulation, and it is therefore rarely resorted to.

Inspection of the rectum may be accomplished to a limited extent by means of a hollow mirror speculum similar to that used in the vagina. It must be provided with an obturator to facilitate its passage through the sphincter. A more perfect examination can be made by means of the tubes of various sizes and lengths which make up the set in Kelly's proctoscope. (Fig. 22.) These are introduced with the patient in a knee-chest position and the rectum is allowed to fill with air so as the better to expose its walls. By this instrument the whole lining of the rectum up to the sigmoid flexure can be examined with reflected or electric light.

Tuttle's proctoscope provides for the distention of the rectum with water, escape of the fluid being prevented by a glass disk. An

PLATE II.

Views of the Interior of the Rectum Seen through the Proctoscope. (Schreiber.)

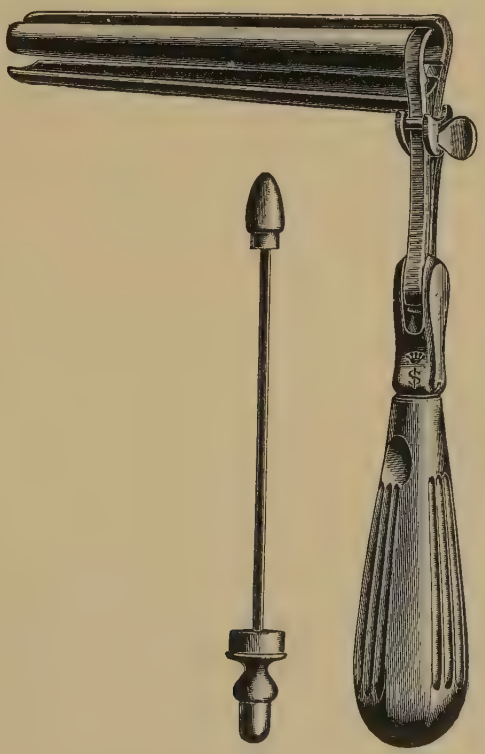
1. Angioma.
2. Oxyuris embedded in the mucosa.
3. Invagination of rectum.
4, 5, 6, 7. Internal hemorrhoids.
8, 9, 10. Fibroadenomatous polyps.
11. Level of external sphincter (normal case).
12, 13. Level of internal sphincter (normal case).
14, 15, 16. At various higher levels (normal case).

electric light is carried at the farther end of the tube, and a continuous flow of water keeps the field of vision clear of small particles of feces and prevents overheating of the parts.

A single-bladed speculum of the Sims type of vaginal speculum is a serviceable instrument for rectal use, but less so for examination than for operation. If the opposite wall of the rectum is pulled down by a sharp hook, it is a practical instrument for the removal of polyps, etc., as far as the ampulla, or even higher.

Bivalve and trivalve specula are also much in use. (Fig. 23.) They are introduced closed and then gradually opened. Before

FIG. 23.



Weiss's rectal speculum.

removal they should be partly but not completely closed, lest the mucous membrane be caught between their blades.

Forcible dilatation of the sphincter is an excellent way to bring the lower part of the rectum into view. This should be done in anæsthesia. The two index fingers are introduced back to back, and slowly separated anteroposteriorly until the fibres of the sphincter are felt to yield. There results a paresis of the muscle without rupture, which passes away in from two to ten days. After forcible dilatation

the lower part of the rectal mucous membrane can be easily rolled outward.

A still wider view of the rectum is gained by posterior sphincterotomy, or a division of the anal canal, including mucous membrane, sphincter, and skin, in the median line back to the coccyx, or even in certain conditions alongside of the coccyx up to the sacrum. In recent years the upper part of the rectum has frequently been exposed to view by laparotomy.

The slight dilatation of the anal canal made necessary by the passage of the finger or the tubular or valvular specula usually requires no anæsthetic. For the use of Sims' speculum, for a forcible dilatation or for cutting operations, one may employ either local or general anæsthesia. For the lesser procedures, Schleich's infiltration method is practical, the skin being first anæsthetized, then the deeper tissues, and finally the mucous membrane. For more serious operations a general narcosis is essential.

CHAPTER VI.

CONGENITAL MALFORMATIONS OF THE ANUS AND RECTUM.

One of the commonest malformations associated with the lower part of the alimentary canal is a failure of the rectal outlet—atresia recti or imperforate anus. In order to relieve this condition promptly and successfully, the surgeon should understand the anatomical and pathological relations of the parts.

Any part of the anal or rectal canal may be the site of closure, and there are therefore several types of atresia of the rectum.

Atresia ani, or imperforate anus, is a failure of the anal opening. Usually the skin shows by a dimple or a swelling the site which the anus should have occupied. The tissue which causes the obstruction may be a thin membrane through which the meconium can be seen; or it may be half an inch or more in thickness. If only a thin membrane obstructs the lumen of the canal, the condition is sometimes spoken of as atresia ani externa. In Fig. 24 the dotted line represents the height to which the ectodermal anal portion normally extends to join the entodermal rectal portion. If the whole length of the anal canal is closed, atresia ani totalis is present; or the lower part of the anal canal may be formed and the closure exist only above.

Fig. 24.

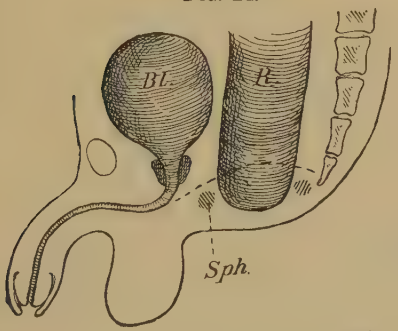
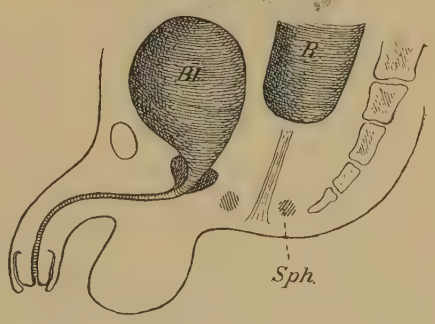


Fig. 25.



Bl, bladder; *R*, rectum; *Sph*, external sphincter.

In this and in most of the forms of atresia recti the external sphincter and levator ani muscles are well developed. Immediately above the obstruction the blind end of the rectum is usually distended with meconium.

Atresia Ani et Recti (Fig. 25).—This name is applied to the failure of the whole or a part of the true rectum. If the obstruction

is low down in the rectal canal, the existing portion of the rectum is usually closely associated with the bladder or uterus. If the lumen terminates high up, the end of the bowel is apt to be covered with peritoneum, and to be freely movable in the abdomen. If so, there often coexists a narrowing of the pelvic outlet, and possibly an absence of the coccyx or even of the last sacral vertebra.

Atresia Recti (Fig. 26).—The anal canal may be open below, terminating blindly above at a distance of from 1 to 7 cm. (0.39 to 2.75 inches). The rectum terminates blindly, and the intervening tissue is usually thin, though it may be thick—measuring perhaps several centimetres. It may be perforate in the centre, and the condition will then be one of membranous stenosis.

In the second and third forms of atresia there will often exist a cord of harder tissue which represents the undeveloped rectum. If such a cord contains a narrow lumen, permitting the escape of small quantities of meconium, it is called a cylindrical stricture of the rectum.

In less than half the cases of congenital closure of the rectum one or more fistulous tracts exist leading from the lumen of the bowel above the obstruction to some part of the urogenital apparatus, or to the external skin. These fistulas are therefore classified as internal or external. In male children the internal fistulas open into

Fig. 26.

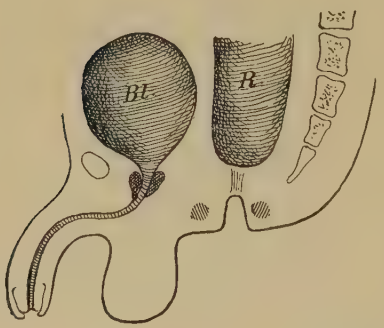
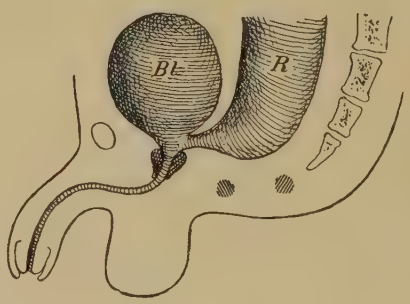


Fig. 27.



Bl, bladder; *R*, rectum.

the base of the bladder (Fig. 27) or prostatic urethra. Such fistulas are usually small, but may admit of the passage of a probe. In female children the fistulas open into the uterus or bladder, very rarely into the vagina. This last condition is not to be confounded with atresia ani with a fistula opening into the vestibule outside of the hymen.

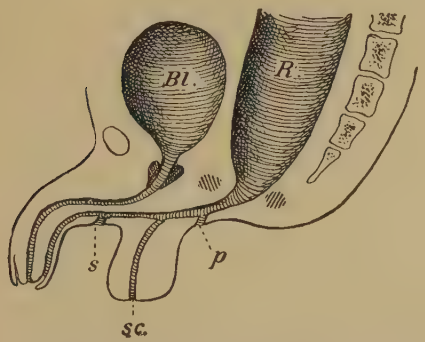
External fistulas in the male may open into the perineal raphé, or in the scrotum, or in the skin of the under surface of the penis. (Fig. 28.) Throughout their course they usually lie close to the skin. In the female their termination is rarely in the perineum, often in the

vulva outside of the hymen. (Fig. 29.) These fistulas are lined with pavement epithelium, and are narrow, admitting a probe with difficulty, except those which terminate in the vulva, which are often of large calibre.

Malformations of the rectum are sometimes complicated with other congenital disturbances, such as hypospadias, exstrophy of the bladder, hermaphroditism, obliteration higher up in the intestine, hydronephrosis, etc.

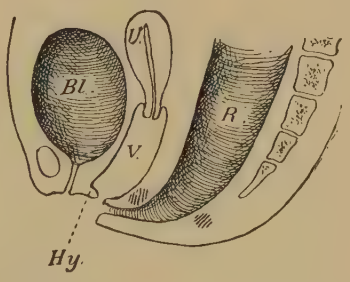
In order that the reader may better understand the complicated forms of rectal atresia he is reminded that at the fourth week of fœtal life the lower part of the intestine terminates in the allantois, forming with it a U-shaped tube opening in the anterior abdominal wall. The two parts of this tube are separated by the septum of Douglas. At the same period a hollow appears in the ectodermal layer at the site of the future anus and deepens until it reaches the junction of the intestine and allantois. It is called the cloaca. The allantois with its

FIG. 28.



Bl, bladder; *R*, rectum; *p*, perineal, *sc*, scrotal, *s*, suburethral fistula.

FIG. 29.



Bl, bladder; *R*, rectum; *V*, vagina; *Hy*, hymen; *U*, uterus.

Müllerian and Wolffian ducts, and the intestine, both empty into the cloaca. Then the septum of Douglas grows downward, and the perineum forms below and grows upward until the two join and the intestinal canal behind is separated from the urogenital apparatus in front. The various rectal abnormalities which have been spoken of are interpreted by some observers as failures of development in the sense that the hollow tubes do not form as they should, or the septa grow to the normal extent and in the normal direction. Other observers hold that the abnormalities are due to adhesions or obliterations of tubes already formed. This discussion belongs rather to embryology than to surgery. Opinion is also divided as to the cause of such malformation. Fœtal peritonitis, intussusception, and syphilis have been given as causes; and instances have been recorded in which heredity seems to have played a part in etiology. Statistics at least show that male and female children are affected in about the same

proportion, and that the frequency of rectal malformation is about 1 in 10,000 births.

Symptoms.—The symptoms of atresia of the rectum vary according to the presence or absence of a fistula. If none is present, symptoms of ileus develop soon after birth. The bacteria introduced by swallowing soon bring about putrefactive changes in the meconium. The abdomen is distended with gas, respiration is hindered, and cyanosis is the result. The infant vomits the milk or whatever it has swallowed, and later meconium. Death follows in from four to six days from collapse, or from peritonitis if the intestine bursts. In rare instances a child has been known to live thirteen days.

If a fistula is present, the symptoms of ileus will still appear in more than half the cases, on account of the fact that very little meconium escapes. In other cases the fistula allows the escape of enough meconium to permit the child to live. It is astonishing how much mucus and meconium can escape through a minute opening of this character. If such an opening is partly or occasionally blocked with some more solid material, symptoms of chronic ileus will arise. Even with a good-sized fistula the child usually suffers from obstinate constipation.

The most favorable type of fistula is the one opening into the vulva. If the opening is small, the fecal matter passes more or less constantly. If it is large, the bowel evacuates itself periodically, and perhaps normally, since both the internal and external sphincter muscles may be normal. The fistula has been found so large that prolapse of the mucous membrane had taken place.

Another favorable type of malformation is the membranous stenosis with perforation. The membrane is usually found at the junction of the anal and rectal portions—that is, from 3 to 5 cm. (1.2 to 2 inches) from the anus in adults. The perforation may be large or small, in the centre or at the side. The larger and more direct the opening, the less the symptoms ; yet patients with narrow tubular connection between the upper and lower parts of the rectum have lived to mature life, though suffering greatly from obstipation.

Perineal and scrotal fistulas are usually so small that they are found with difficulty unless discharging meconium. Yet even this condition is not necessarily fatal.

Vesical and urethral fistulas are more dangerous. Even if they are large enough to allow the escape of meconium, infection of the urinary passages speedily follows, and the child is likely to die from cystitis, calculous formation, or pyelonephritis. Meconium which passes into the bladder is dissolved in the urine and easily passed by the urethra. If it passes directly into the urethra, it may cause considerable obstruction on account of its lumpy character. The prognosis of vesical or urethral fistula is therefore almost as bad as that of atresia without fistula. It is usually possible to determine whether a urinary fistula is vesical or urethral. In vesical fistula the meconium

is intimately mixed with the urine, the urine always contains some of it and speedily becomes foul. In urinary fistula the opposite of all these conditions exists, and meconium may pass from the meatus without urine.

Prognosis.—Without operation all the cases of complete congenital atresia of the anus and rectum terminate fatally. This is also true of the majority of the cases of atresia combined with fistula. In some instances life is prolonged for a few days or for some months or years with more or less difficulty. In rare cases the health of the child is unaffected.

Treatment.—If the obstruction is total or nearly so, an operation for its relief must be performed at once. It is of advantage if it is done in the first or second day of life. If the infant is left until symptoms of ileus begin to appear, the outcome of operation is less favorable. Unfortunately surgical aid is usually not sought until the abdomen is distended and possibly peritonitis is present. If the intestinal contents find a partial discharge through a fistula, the operation may be longer delayed provided no symptoms of ileus are present.

The object of operation is twofold: first, to afford free escape for the fecal contents of the bowel; second, to affix the rectum, whenever this is possible, in its normal situation at the anus, in order that the sphincter muscle, which is almost always present, may prevent incontinence of feces. If the intestine is so high up that it is not possible to bring it down to the anus, an artificial anus must be elsewhere established.

Complete Occlusion of the Rectum without Fistula.—The simplest cases are those in which the rectum is well formed and there is at the anus a superficial epithelial closure. The finger is sufficient to bore through and so establish a cure. If the anus or rectum is closed by a thin membrane which bulges outward when the child strains, and through which the dark meconium can be seen, this membrane should be divided anteroposteriorly and cut away with a pair of scissors.

If the soft parts which obstruct the passage in atresia ani have a considerable thickness, say, up to 1 cm. (0.4 inch), but still bulge outward when the child strains and permit of distinct signs of fluctuation, the proper operation is a median anteroposterior incision extending from the scrotum to the coccyx. (Heister.) This incision must be exactly in the middle line in order to divide the external sphincter in its anterior and posterior raphe, since thus its function is less disturbed. For this reason a crucial incision is not advisable. As soon as the meconium has escaped and the bowel has been washed out the cut is extended in an anteroposterior direction until it equals the diameter of the rectum. The mucous membrane and skin are then united by a silk suture. If an exact approximation of the skin and mucous membrane is omitted, the result is apt to be cicatricial contraction and stenosis. The plan previously followed, of plunging a trocar through into the rectum, is absolutely to be condemned.

The farther from the surface the obstructing membrane is situated, the more difficult the operation. In such cases it is of great interest to know about how far downward the lumen of the bowel extends, in order to avoid a needless operation. If when the child strains a bulging can be made out in the region of the anus, it is certain that the intestine is not far away. The reverse of this statement is not always true. This bulging has been absent when the obstruction was only 3 cm. (1.8 inches) in thickness. A general narrowing of the pelvis, the result of total absence of the rectum, is more significant. Jacubowitsch's measurements of the normal infant at birth show that the distance between the tuberosities of the ischia is at least 5 cm. (2 inches); the distance from the coccyx to the symphysis 6 cm. (2.4 inches); and the distance from the coccyx to the promontory is also 6 cm. (2.4 inches). A considerable reduction of the first measurement is especially significant of a high termination of the intestine. Here again the reverse of this statement is unreliable, since an intestine may end high up although the pelvis is normally developed. The operation usually done for this condition is colostomy. Esmarch and König and Rotter believe that in all cases an attempt should be made by the perineosacral route to find the intestine, empty it, and stitch it in the normal situation in order that the external sphincter may afford continence. Such an operation has proved successful even though the lumen of the bowel ended 9 cm. (3.2 inches) above the anus. If the atresia extends higher up than this, the operation to be performed is similar to that for resection of the rectum.

The patient lies upon his back in light narcosis; an incision is made from the scrotum or vulva to the coccyx in the median line. If more room is needed, the incision is extended higher and the coccyx removed, or bent backward. In some instances the incision may extend alongside the sacrum and divide the glutæus maximus and the sacrosciatic ligaments. Sounds should be passed into the bladder and vagina in order to protect them during dissection. The deeper incision is also made exactly in the middle line in the search for the dark-blue tense fluctuating end of the bowel. If this is not readily found, search is made in the hollow of the sacrum by blunt dissection. If the intestine is not found here, Douglas's pouch may be opened. This is situated in the newborn infant from 2 to 3 cm. (0.8 to 1.8 inches) above the skin of the perineum. It should be torn through with the finger, and the opening in it carefully enlarged with scissors. The finger is then passed into the peritoneal cavity and at once detects the lower end of the intestine. This is seized with clamps and drawn downward with the help of the fingers, which carry out the blunt dissection. Here it is brought outside of the anus, but not opened until the peritoneal incision and the wound cavity are tamponed with iodoform gauze, so that the meconium escapes without soiling the wound. The bowel is irrigated and the cut is enlarged anteroposteriorly until it equals the diameter of the bowel. The mucous membrane is stitched to the skin and the external sphincter

is sutured anteriorly. It is absolutely necessary that the suture of mucous membrane to the skin be without tension, otherwise the stitches will cut out, the rectum will retract, and the ring of granulations will cicatrize with distinct contraction. Such a stenosis in infants is not much benefited by the passage of bougies, and the treatment is an extremely disagreeable one to carry out. If the blind end of the bowel is more than 2 or 3 cm. (0.8 or 1.2 inches) from the surface, it cannot be brought down without a systematic dissection, and unless Douglas's pouch can be pushed away from the bowel it must be cut into in the manner above described.

If atresia recti exists together with a formed anal canal, the operation is performed as follows: A median incision is made backward from the anus dividing the anal canal throughout its length. The anal mucous membrane is dissected out, care being taken not to injure the sphincter. The loosened intestine is then brought out through the sphincter and sutured.

In a considerable number of cases the operator has failed to find the intestine by searching for it from below upward, either on account of its high situation or by reason of his own lack of skill or persistence. Curling and Anders say that a perineal operation has failed in 30 per cent. of the cases. In other cases the intestine has been found, but has not been sufficiently freed to bring it to the anus. Under such circumstances the intestine may be emptied of its contents and further attempts made to loosen it sufficiently to permit of its suture to the skin. This procedure exposes the wound to the risk of infection. The sigmoid flexure has been brought down and stitched in the anus. If the end of the bowel cannot be found, or if found cannot be brought to the surface, the wound should be tamponed temporarily and the abdomen be opened either on the left side or in the median line. Through this wound the rectum and, if necessary, the sigmoid flexure should be loosened to the extent of 7 or 8 cm. (2.8 or 3.2 inches) and brought out through the perineal wound. If the lower end of the intestine is so distended with meconium as to interfere with manipulation, its contents may be squeezed back into the colon. The abdominal incision is next closed, the abdominal wound again packed with gauze, the intestine opened and irrigated and finally stitched to the skin.

If the conditions are such, on account of ileus and abdominal distention or lack of assistance, or on account of the high termination of the lumen of the bowel it is not possible to bring it down to the anus, nothing remains except the establishment of an artificial anus, the opening being made in the sigmoid flexure, which is brought to the surface on the left side. (For details of this, see Vol. IV., page 461.) It may be possible some months later to bring the bowel to the natural anus, to open it, to close the artificial anus, and thus to cure the patient. It is worth mention that in about 12 per cent. of the cases the sigmoid enters the pelvis from the right side, so that the artificial anus may need to be made in the median line, or even on the right side.

Occlusion of the Rectum combined with Fistula.—If a fistula exists in addition to the occlusion, both conditions require treatment. Internal fistulas, whether vesical or urethral, are most difficult to treat, especially if the intestine terminates high up and is intimately attached to the bladder. The operation begins like that for the treatment of complete occlusion high up, with a perineal sacral incision, extirpation of the coccyx, and loosening of the bowel behind and at the sides. On account of the adhesions to the bladder this kind of loosening is not sufficient. If the intestine is opened, the wound is at once infected. Some fecal matter still passes through the fistula into the bladder, and, what is still more important, the operation will be followed by cicatricial stenosis. Hence it is necessary to separate the bladder and intestine. This is a difficult thing to do. A sound is passed into the urethra and thence through the fistula into the rectum. If the fistula can be located in this manner or otherwise, it is separated as much as possible and then clamped and divided. The intestine is then freed, brought down and stitched to the skin, and an attempt is next made to close the opening in the urethra by suture. If the fistula extends from the rectum to the bladder, it is still more difficult to treat, and yet it must be closed in order to prevent the passage of feces into the bladder. It will be necessary to open the peritoneal cavity—a step which is difficult or impossible through the sacral wound. It is better to make an abdominal incision through which to separate the intestine and bladder and to suture the opening in the bladder, and to complete the mobilization of the intestine. This operation is so difficult that operators have usually contented themselves with an artificial anus.

Atresia ani complicated with an external anus is far easier to handle. In case of a vulvar fistula a sound may be passed into the rectum and brought out to the anus and cut down upon. The mucous membrane and skin are then stitched together. This simple procedure may cure the trouble, but fecal matter is apt to pass along the open gutter into the vulva. A perfect result will be secured if the bowel is separated from the vestibule and opened in the normal position of the anus. In these cases there is usually no incontinence even before operation, since the fistula to the vulva is placed outside of the internal sphincter. To cure such a case, a median incision is made from the posterior commissure to the coccyx. A sound is passed into the fistula and the fistulous passage is dissected free from the vulva, and the rectum is separated from the vagina and at the sides sufficiently to allow it to be brought into its normal position. Its closed end is then split from in front backward and the mucous membrane and skin sutured. The posterior vaginal and vulvar wall is next sutured, and finally the perineum is restored by the suture of the skin between the commissure and the anus.

Perineal, scrotal, and suburethral fistulas are treated by passing a probe throughout their length and dividing the overlying skin. The mucous membrane is then stitched to the skin and gradually changes in

character. If the fistula is too deep for this treatment, it should be excised and the wound sutured.

The after-treatment of the wound is in accordance with the principles given for treatment after removal of the rectum for carcinoma. (Page 168.) These patients usually withstand the loss of blood, and the risk of infection is not so great as it otherwise would be, on account of the fact that the meconium contains few bacteria. Anders collected statistics of 100 cases operated upon before the year 1893, which were divided as follows:

	Cases.	Mortality.
Atresia ani	11	27 per cent.
Atresia recti	27	40 "
Atresia ani et recti	18	55 "
Atresia vesicalis et urethralis	12	75 "
Atresia vestibularis	27	7 "
Atresia perinealis et scrotalis	5	20 "

Most of these operations were performed in the antiseptic era. Three patients were not operated upon, and in 23 cases the intestine was either not found or was simply punctured or incised; 14 of these 23 patients were later subjected to colostomy; the other 9 died without further operation. Colostomy was the only operation performed upon 7 patients. The various methods of operation resulted as follows:

	Times.	Mortality.
Proctoplasty	44	29 per cent.
Incision	27	33 "
Colostomy	21	52 "
Puncture	4	50 "

These statistics show very plainly that the prognosis in any instance depends upon the nature of the obstruction. Still older statistics collected by Cripps and Curling show a mortality of 50 per cent., whereas Anders' statistics show a mortality of only 37 per cent. Only 13 of the 29 patients who survived a plastic operation were freed from subsequent incontinence.

CHAPTER VII.

INJURIES OF THE RECTUM.

Etiology.—The rectum may be injured by the entrance into it of foreign bodies, as described on page 94, and also in other ways. For example, a child sits on a porcelain vessel which breaks, and a sharp fragment makes a wound either in or near the anus; or a person falls upon some sharp object, such as a fence-picket, or is hooked by a cow. A bullet may pass through the pelvis wounding the rectum. If the bullet passes in an anteroposterior direction, the bladder and peritoneal cavity are usually opened and peritonitis follows. If the bullet passes from side to side, vessels and nerves are apt to be injured as well as the rectum. The rectum has often been injured by the unskilful introduction of instruments. Thus the point of a syringe has been introduced so clumsily that it has penetrated the rectal wall and the fluid has escaped into the perirectal tissue. A gangrenous process with considerable loss of tissue may cause the death of a patient, or may be followed by stricture if the patient recovers. Or the syringe-point may simply scratch the mucous membrane, giving rise to ulcers usually situated in the anterior wall of the anal portion, which may contract during healing and produce a stricture. In women the rectum is often injured during difficult childbirth, either because the head of the child pressing too long upon the rectovaginal septum causes gangrene, or because the head in its passage tears the perineum and with it the sphincter muscle. Spontaneous rupture of the rectum may be produced by strong abdominal pressure if the rectum is prolapsed and its wall is thin. Intestinal coils may pass out through the rent and thus protrude, and be difficult to replace. The rectum may also be injured by articles introduced by an insane patient or with criminal intent.

Symptoms.—Injury of the rectum may produce severe hemorrhage without any external sign. This occurs when the rectum is injured above the functionally active sphincter. The blood collects in the rectum and passes into the sigmoid flexure and even the colon; or, if the peritoneum has been opened, it passes into the peritoneal cavity. In this manner so much blood may be lost that the symptoms of acute anæmia—marked pallor, small, frequent pulse, weakness, etc.—develop before a single drop of blood passes from the anus.

A second peculiarity of rectal injuries consists in the fact that the wound is exposed in a high degree to infection. The penetrating foreign body may carry with it feces into the tissues, or, what is more likely, fecal matter subsequently finds its way into the wound.

Injuries below the levator ani are more favorably situated than those above. An active sphincter may increase the danger from infection just as it may increase the danger from hemorrhage. The fecal matter collects in the ampulla, where it is held back by the sphincter; and before it passes during defecation it is subjected to increased pressure; hence it is really pressed into the wound, and intense inflammation and fecal infiltration may be the result. If the injury is below the levator, the feces and pus reach the surface without difficulty. If the wound is above the levator ani and has penetrated into the pelvirectal space, the resulting suppuration is apt to extend to the retroperitoneal connective tissue, producing sepsis and pyæmia and speedy death. If the peritoneum is wounded, septic peritonitis may follow. Perforation of the bladder may lead to infiltration of urine and gangrenous cystitis.

Treatment.—Much is to be gained by prophylaxis. Thus the change from rigid syringes to irrigators with a flexible tube has almost done away with rectal wounds produced during the administration of an enema. Proper assistance during delivery will usually prevent injuries to the rectum from this cause. Hemorrhage from the rectum following injury ought to be carefully controlled since it may easily go on to an alarming extent, and because the blood is exposed to degeneration. If the bleeding vessels are not within easy reach, it is important under anæsthesia to dilate or divide the sphincter muscle, and by means of speculum and hooks to expose the wound throughout its whole extent. In case of a punctured wound it may be necessary to make a cut through it. The bleeding vessels can then be ligated. Parenchymatous bleeding can be controlled by irrigation with cold water. Diffuse bleeding may be stopped by elevation of the pelvis either upon the operating-table or in bed. The wound should be tamponed with iodoform gauze and a tube wrapped in iodoform gauze should be left in the anus to allow the escape of gas. Wounds which communicate with the rectum had better not be sutured primarily. If the parenchymatous or diffuse bleeding cannot be controlled by the means above mentioned, the whole rectum may be tamponed with iodoform gauze for several days. If Douglas's pouch has been opened and blood has escaped into the peritoneal cavity, an abdominal incision should be made to remove it if there is danger of infection from the rectal wound.

When the hemorrhage of the rectum has been controlled, the efforts of the surgeon should be directed to prevent infection. The rectum should be irrigated with a solution of lysol or boric acid, or salicylic acid. If the sphincter is active, a double-current catheter should be employed, or a speculum inserted in order to permit escape of the irrigating fluid and such clots of blood and masses of feces as may be present. Large doses of opium should be given for a few days in order to keep fecal matter out of the rectum. The wound should be protected by iodoform gauze packing from secondary infection. If

the wound is situated below the levator ani, it can be freely drained by a posterior sphincterotomy even though it is a complicated one. Wounds which are situated above the levator ani can be freely drained only by a parasacral incision, combined perhaps with resection of the coccyx. Secondary suppurations are to be treated in accordance with the principles given on page 110. If the peritoneal cavity is opened by violence, an immediate laparotomy should be performed in order to prevent peritonitis.

The danger of complicated injuries of the rectum is given as follows: Quénu reports 27 deaths and 9 recoveries after 36 rectal injuries complicated with opening of the peritoneal cavity. Van Hook mentions 11 cases of rectal injury due to falls on pickets; in 6 of these the peritoneum was uninjured and the patients all recovered; the remaining 6 suffered injury of the peritoneum, and all died. Otis says that there were 44 deaths following 103 gunshot-wounds of the rectum, usually due to septic cellulitis.

FOREIGN BODIES IN THE RECTUM.

Foreign bodies in great variety are found in the rectum. They are sometimes articles which have been swallowed and have passed through the intestinal canal, such as pieces of bone, articles of jewelry, knives, forks, etc. Small articles pass the intestinal canal in from one to nine days; the larger ones often require much more time, even months and years. Sometimes foreign bodies enter the rectum through the anus. For example, if a patient falls or leaps, striking upon a fence, or a branch of a tree, or a bottle. Insane persons, and those with perverse sexual desires, sometimes push all sorts of articles up into the rectum.

Fecal calculi may either enter the rectum from the large intestine or may form in the ampulla and grow to be several inches in diameter. They consist of dried fecal matter mixed with undigestible remnants of food, such as cherry- or plum-pits and fibres of plants. A favorable condition for their development is a distended, feeble rectum, such as is found in paralytics, in cachectic persons of advanced years, and in those who regularly take morphine or opium. Fecal calculi not larger than a pea are sometimes found in abnormally deep pouches of Morgagni, where they produce little ulcers and may give rise to perirectal abscesses.

Symptoms.—Many foreign bodies, even though of considerable size, are passed without difficulty; but sometimes, and especially if they have a rough surface or angles, they may catch in the folds of the mucous membrane or against the sphincter muscle, and so remain in the ampulla. There is no part of the intestinal canal which affords such an obstruction to the passage of foreign bodies as the sphincteric portion of the rectum. Hence many foreign bodies, being incorporated in a

fecal mass, wound the mucous membrane as the mass passes outward, and give rise to inflammation, or fissure, or ulcer. Others are passed deeply into the rectal wall and set up diffuse perirectal suppuration, in which one frequently finds a small splinter of bone or other foreign body. Larger obstacles may catch in the ampulla, and by constant pressure upon the rectal wall they may perforate into the vagina, or bladder, or peritoneal cavity. It is readily understood that foreign bodies which are pushed into the rectum from below with violence may also give rise to more or less serious injury.

If a foreign body with a rough surface, or in an unfavorable situation, remains for some time in the rectum, it produces serious symptoms, such as pain, disturbance of defecation even up to the point of acute ileus, catarrh, with discharge of mucus and blood, painful tenesmus, and finally a paresis of the sphincter muscle with involuntary discharge of mucus and feces. Fecal calculi may remain for a long time in the rectum without causing serious symptoms. There are usually a feeling of weight, and obstinate constipation with some symptoms of approaching ileus, alternating frequently with diarrhœa. The condition is therefore similar to that found in stenosis of the rectum. (See page 120.) Constant pressure upon the mucous membrane leads to chronic catarrh, ulcers, dilatation of the hemorrhoidal veins, and perhaps to paresis of the sphincter and prolapse.

Diagnosis.—If digital examination is neglected, an error in diagnosis can scarcely be avoided. The patient often says nothing of the foreign body in the rectum either because he is unconscious of it or is ashamed to mention it. Mistaken diagnoses often made are hemorrhoids, rectal catarrh, prolapse, or ileus. If the examination is physically made with the finger and speculum, one will rarely fail to discover the cause for the symptoms which are present.

Treatment.—If the foreign body is of simple character, the patient should be given injections of oil in the hope that he will pass the foreign body naturally. Laxatives should never be given. The increased peristaltic action which they cause is apt to wedge the foreign body still more firmly in the wall of the rectum, and to increase the risk of infection. If the treatment with oil injection is not successful, the foreign body should be removed with the finger or with the speculum, or a pair of forceps, or a spoon, according to circumstances. If these attempts do not succeed, or if the foreign body is not accessible on account of its shape, or size, or position, the patient should be given an anæsthetic and the sphincter dilated, a speculum introduced, and the foreign body removed by proper instruments. A posterior division of the sphincter with the extension of a cut to the coccyx or even to the sacrum, may be necessary if the foreign body is of great size or is wedged transversely in the rectum. The surgeon should above all things avoid violence. It is better not to break a foreign body, but to remove it whole. If the foreign body is situated in the upper part of

the rectum or in the sigmoid flexure, it may be necessary to remove it through an abdominal incision. Monad in 1898 reported 27 instances of foreign bodies in the rectum which were removed through the natural passage; death followed in 5 instances; but in 2 of these the intestine was injured before the attempts at extraction were made. He also reported 7 cases in which the foreign body was removed by posterior division of the sphincter or rectum or by laparotomy.

CHAPTER VIII.

DISEASES OF THE ANUS AND RECTUM.

INFLAMMATION OF THE RECTUM AND ITS NEIGHBORHOOD.

Inflammations of the Skin.

Intertrigo.—A superficial, acute inflammation of the skin about the anus is called intertrigo. It occurs especially in stout individuals, as a result of chafing between the nates, favoring influences being increased perspiration, uncleanliness, and diarrhœa.

Symptoms.—The affection is marked by burning and pain, which may increase while the patient is going about until they are unbearable, and which usually subside during a period of rest. If the nates are drawn apart, the skin will be found red, wet, and possibly excoriated in places.

Treatment.—Rest, in bed if necessary, and cleanliness are essentials of treatment. If the hairs are matted together, they should be loosened by a cool bath and cleansed, not cut off, on account of the irritation caused by their short stumps. A soothing ointment or powder should then be applied. Excoriated spots should be touched with a 3 or 5 per cent. solution of silver nitrate and then smeared with ointment. The inflammation may be controlled by ice or cold compresses, or with lead or aluminum acetate. In order to avoid recurrence the patient should wash the parts daily with cold water after defecation, dry them, and then apply an ointment or powder.

Pruritus Ani.—The causes of this affection are sedentary habits, constipation, rectal catarrh, hemorrhoids, rectal polypi, affections of the uterus, diabetes, and the use of certain articles of foods, for example, lobsters, crabs, coffee, etc. In children the itching may be due to the presence of pin-worms.

Symptoms.—The chief symptom is an annoying itching, which is usually increased when the patient is warm in bed. This may be so aggravated by scratching that sleep is disturbed the greater part of the night. Sometimes on examination absolutely nothing abnormal is to be found. At other times the effect of rubbing and scratching is evident. If the trouble has existed a long time, there may be an inflammatory thickening of the skin about the anus, which then lies in ridges, and may also present a papillomatous appearance. Catarrh of the rectum may be set up by the irritation due to scratching.

Treatment.—An attempt should be made to remove the cause—constipation, hemorrhoids, worms, or whatever it may be. Unfor-

tunately, in many cases no cause can be ascertained for this trouble, and the physician must content himself with local treatment. Ointments of various kinds have been recommended, such as one containing 10 per cent. of chloroform; one composed of equal parts of calomel and vaselin; one containing balsam of Peru, and other combinations recommended for eczema. Painting the parts with a solution of silver nitrate may give relief. A thorough washing with water and soap, followed by rubbing with alcohol and a solution of mercuric chloride, as is done in the preparation of a patient for operation, will oftentimes relieve the itching. Very hot fomentations may be of service. Allingham advises the use of the dumb-bell hard-rubber pessary at night. (See page 130.) A still more radical measure which often produces a brilliant cure is the forcible dilatation of the sphincter. If the skin is deeply inflamed, with fissures and papillomatous excrescences, the use of a sharp spoon or of the thermocautery may be necessary. Internally one may give arsenic, iron, quinine, etc. Opium is apt to aggravate the trouble.

Furunculosis.—The skin about the anus is a favorite seat for boils, on account of its numerous sweat- and fat-glands and the more or less constant presence of septic material.

Treatment.—Small pimples should be treated by warm, wet compresses, larger ones should be opened in accordance with the recognized principles for the treatment of furunculosis of the skin elsewhere in the body.

Inflammations and Ulcers of the Rectum.

Simple Proctitis and Ulcers of the Rectum.—Etiology.—Simple acute proctitis may be due to mechanical irritation, the result, for example, of the continued use of highly spiced food, or the mistaken use of strong laxatives, especially aloes, jalap, and colocynth. Exposure to cold and dampness, as by sitting in a cold privy or on the cold ground, is also mentioned as a cause. Mechanical causes, such as injuries and the presence of foreign bodies, may also excite proctitis. The most important mechanical causes are hard fecal masses, too hot injections, injuries with syringe-nozzles, scratching with the finger-nails in the case of pruritus, and the presence of pin-worms. The rectum may become inflamed secondarily as a result of inflammation of the small intestine or large intestine, or on account of the presence of hemorrhoids, prolapsus, perirectal inflammation, polypi, carcinoma, etc.

Chronic proctitis may develop from a long-standing acute inflammation or it may develop primarily.

Pathological Anatomy.—In acute proctitis the mucous membrane presents the usual appearance of acute inflammation with superficial erosions and swollen follicles, which may suppurate and perforate, and give rise to small ulcers. Chronic proctitis is marked by proliferation of the interglandular connective tissue. In severe cases the submucosa

is also involved. As a result, if the disease lasts a long time, the thickened mucous membrane is puffed up in places and may present a polypoid appearance; hence the name proctitis proliferans polyposa. On the summits of these inflammatory polypi the cylindrical epithelium may be changed into a simple stratified epithelium; also, the crypts of Lieberkühn may dilate or undergo cystic degeneration. If the disease lasts a long time, the deeper layers of the rectal wall, including the muscular and subserous coats, may be involved in the inflammation. The new-formed connective tissue may later contract and give rise to stricture. The seat of a simple catarrh of the rectum is usually the ampulla, whence it extends also into the anal portion.

Symptoms.—Acute proctitis begins with fever, heat, and pain in the rectum and extending to the sacrum, thighs, bladder, and penis. The most striking symptom is an intense, frequent desire to evacuate the bowel, known as tenesmus. This violent straining produces only a small quantity of fluid mucus. In children the straining frequently causes the inflamed mucous membrane to protrude from the anus. By an extension of the irritation to the neighboring organs there may be produced painful micturition, retention of urine, penile erections, etc.

Chronic proctitis may exist for some time before it is recognized, producing merely a feeling of pressure and fulness in the pelvis. Later there may be a rather frequent passage of glairy or purulent mucus. When the disease has advanced to the proliferous or ulcerative stage, the patient may suffer from obstipation, or from more or less tenesmus, or from liquid movements and the passage of mucus and pus. The tenesmus is especially prominent on waking in the morning, when the desire to evacuate the secretion that has collected during sleep is well nigh irresistible. This frequent passage of fluid irritates the skin of the anus, and may cause fissure, relaxation of the sphincter, prolapse of the mucous membrane, etc. The clothing is constantly soiled. The disease may be complicated with perirectal suppuration. It may terminate in stricture; or the absorption of the purulent fluids may produce a chronic sepsis, with more or less constant headache, disturbance of the digestion, etc.

Treatment.—In the treatment of acute proctitis an attempt should first be made to discover and remove the cause. If the symptoms are marked, the patient should remain in bed with the pelvis elevated. The diet should be carefully regulated, and all articles of food forbidden which leave a considerable residue after digestion. The rectum should be regularly emptied by daily irrigations with saline solution, oil, oatmeal-water, etc. In order to quiet the pain and tenesmus opium may be added to the injection; or a suppository of morphine, cocaine, or opium may be given after the injection. Cool sitz baths and the local application of ice or an ice-bag will also give the patient great comfort. By these means acute proctitis can be cured in one or two weeks.

The longer a chronic proctitis has existed, the more tedious will be the recovery. The same rules for diet and daily irrigations as are laid

down for acute proctitis are essential for the treatment of chronic proctitis. In recent cases they may suffice to effect a cure. To them may be added daily irrigations with astringents, such as a solution of silver nitrate (1 : 2000), the strength of which may be gradually increased; hydrogen peroxide diluted with 6 to 12 parts of water; a solution of itrol (1 : 8000), or of tannic acid (1 : 200), or of zinc sulphate (1 : 200), lead acetate (1 : 300), etc. A soft rubber tube should be passed through the anus, and when mucus, pus, and feces have been washed out through it, from 100 to 200 c.c. of the medicated solution should be injected. Three to five minutes later the fluid should be allowed to escape and the tube be withdrawn. Another method is to employ a double-current catheter. Recently Reclus has recommended long-continued irrigations with very hot water, up to 50° C. (122° F.). After disinfection of the intestine such internal remedies as naphthol, bismuth subnitrate, and balsam of copaiba, turpentine, etc., may be administered. Ulcers should be treated through the speculum by strong solutions of silver nitrate, zinc chloride (1 : 8), tincture of iodine, etc., or they may be touched with a solid pencil of silver nitrate or with the point of a galvanocautery. Polypoid excrescences should be cut off with scissors or the thermocautery. If the condition of the rectum is very bad, and deep infiltrations of its walls, profuse suppuration, and symptoms of sepsis are present, more radical surgical treatment is necessary, such as extirpation of the rectum, entero-anastomosis, or colostomy. These operations are described under Strictures of the Rectum.

Gonorrhœal Inflammations and Ulcers of the Rectum.—**Etiology.**—Gonorrhœal proctitis may be transplanted by the flow of secretion from the vulva to the anus; or by the direct implantation of the gonococcus in the male or female rectum; or rupture of a suppurating Bartholin's gland into the rectum. Therefore gonorrhœa of the rectum is far more common in women than in men. Indeed, recent investigations show that it is present in about one-third of the women who have gonorrhœa of the vulva.

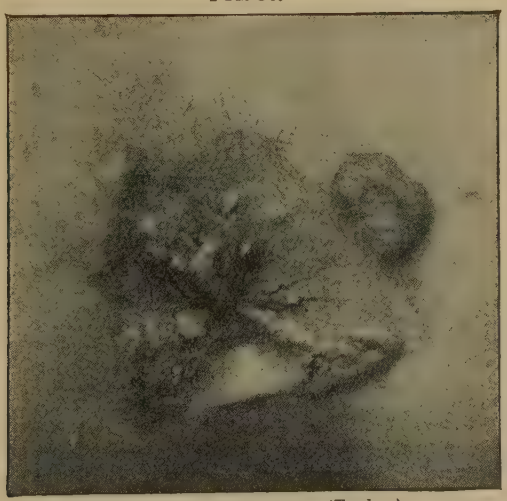
Symptoms.—Gonorrhœal proctitis does not at first produce marked symptoms. On examination the mucous membrane will be found to present the symptoms of a highly chronic catarrh, with a few superficial erosions and a small amount of mucous or purulent secretion. Sometimes painful fissures of the anus are present, from which ulcers may later develop and spread upward in the rectum. The erosions are less likely to form ulcers of considerable depth. The gross appearance of the rectum is not sufficiently well marked to enable one to make a positive diagnosis; this depends upon the bacteriological examination of the secretion. The inflammation will lead to infiltration of the deeper parts of the rectum and the periproctal tissues, so that years later cicatricial contraction and stricture may follow. Gonorrhœa rarely exists above the ampulla. The irritating discharge may give rise to condylomata.

Prognosis.—In recent, simple cases the outlook is favorable. The ulcerative and chronic forms are serious on account of the cicatricial contraction which is likely to follow.

Treatment.—In addition to the measures suitable to the treatment in proctitis, injections of protargol (0.5 to 1 per cent.), or argonin (1 to 5 per cent.) to the quantity of 50 c.c., may be employed; or the rectum may be irrigated with a solution of silver nitrate (1 : 4000 or stronger) or potassium permanganate (1 : 5000 or stronger). Frequent introduction of the speculum is to be warned against, since it is likely to increase the ulceration above mentioned. If the ulcers do not heal as a result of the treatment, they should be excised.

Ulcus Molle.—Chancroid of the rectum usually occurs in women as a result of the flow of infectious material from the vagina or as a result of direct implantation. There are usually multiple ulcers situated in the anal folds, where they form fissures or round ulcers. They are rarely found higher up in the rectum. If the parts are kept scrupulously clean, healing generally follows. In a few instances, however, the ulceration takes on a purulent character and destroys large areas of the skin of the anus, of the rectovaginal septum, or of the mucous membrane of the rectum. Such conditions should be treated according to the principles described on pages 100 and 103.

FIG. 30.



Condylomata of the anus. (Taylor.)

Syphilitic Affections of the Anus and Rectum.—Hard chancre is seldom seen in the rectum, where it is less common in men than in women. It is situated either in the skin about the anus, or hidden in one of the folds, or in the anal canal, rarely in the true rectum. Unlike the soft chancre it is never multiple. The inguinal lymph-glands are enlarged unless the chancre is situated in the true rectum,

in which case the lymph-glands associated with the rectum are enlarged.

Secondary symptoms of syphilis are often manifest about the anus, originally in the form of papules and scales. Under the influence of the moisture present between the nates they develop into flat, rounded, sharply defined elevations with a pearly surface,—the condylomata lata. (Fig. 30.) As these grow they may join together, but a line of demarcation will reveal their separate origin. The epidermis covering them may be destroyed by chafing and secretion, so that ulceration follows. These condylomata are to be found not only in the skin about the anus, but also on the perineum, posterior surface of the scrotum, and in the anal portion of the rectum.

The tertiary symptoms of syphilis frequently occur in the rectum, but rarely in the skin about the anus. It sometimes happens, however, that a patient will present himself with one or several gummata in the skin about the anus, or in the region of the sphincter, or in the central portion of the rectum. The usual form of the disease is, however, a diffuse affection of the rectal wall. This is due to the development of numerous miliary nodules representing a specific endarteritis and endophlebitis and periphlebitis. The sphincter is also generally affected. These miliary gummata may soften in the centre and perforate the mucous membrane. The resulting ulcers may join together, forming larger ulcers. At the same time the miliary gummata in the deeper portions of the rectal wall undergo degeneration and cicatrization. It is easy to see how such a process may terminate in abscesses and fistulas; or, in healing, with marked cicatricial contraction. To a specific infection is soon added a simple inflammation due to the passage of fecal matter. The mucous membrane may be altogether lost throughout a considerable extent, while the rectal wall may have a thickness of 0.5 to 1.5 cm. (0.2 to 0.6 inch) and consist of tissue almost as hard and inelastic as cartilage. In the final stages of the disease, when the syphilitic process has run its course, only the results of the inflammation and the suppuration will remain.

Syphilitic disease of the rectum begins as a rule just above the sphincter, and spreads upward sometimes into the sigmoid flexure. It is a curious fact that men rarely suffer from it. This is explained by Rieder, who found that the primary lesion in women is frequently situated in the posterior commissure of the vulva. From this point the veins of the pelvivaginal plexus are infected, and, indirectly, the veins of the rectal plexus, since these plexuses are intimately associated. In men, however, the initial lesion in the penis infects the veins of the iliac plexus. This explains not only the rarity of tertiary lesions in the male rectum, but it also explains why the tertiary trouble manifests itself in the lower part of the rectum in the female.

Symptoms.—The diagnosis of primary and secondary lesions is easily made. Tertiary syphilis of the rectum is an obscure disease

PLATE III.

FIG. 1.

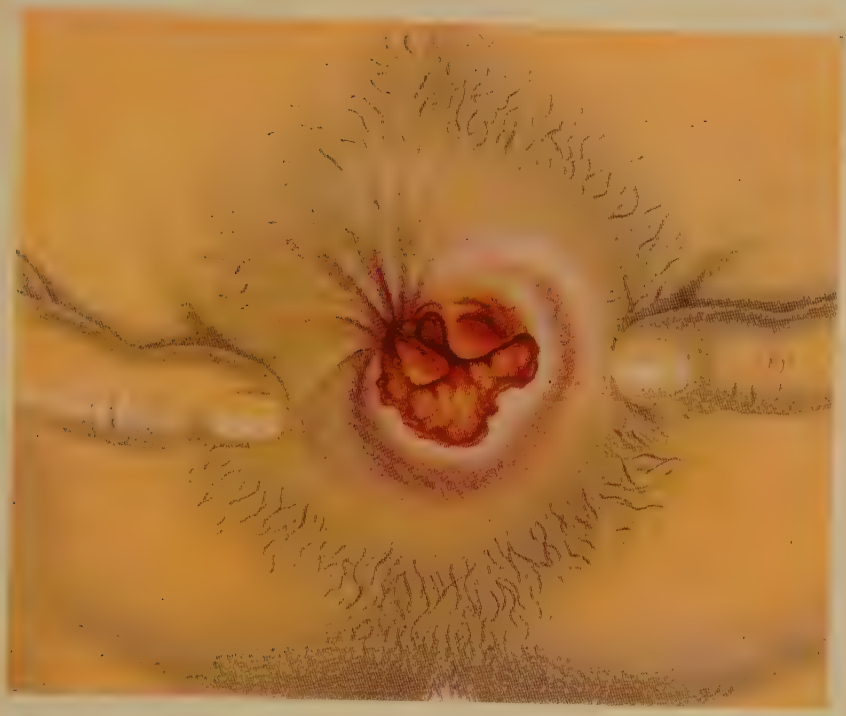


FIG. 2.

Tuberculous Ulceration of the Anus. (Quenu and Hartman.)

until gross changes in the mucous membrane have developed. Upon examination one finds at first the symptoms of chronic proctitis, later ulcers, and finally stricture.

Prognosis.—When primary or secondary symptoms are present, the prognosis is favorable. If the tertiary stage has been reached, the prognosis is bad, because the disease in most instances is not recognized until severe and possibly irreparable changes have taken place in the rectal wall.

Treatment.—Local cleanliness is most important, and should be secured by frequent bathing. The diseased parts should be dusted with iodoform or orthoform, or dermatol. Condylomata should be washed with saline solutions and dusted with calomel. The skin should be kept dry by absorbent cotton placed between the nates. Proctitis should be treated in accordance with the rules given for simple chronic proctitis. Constitutional treatment should be immediately begun and faithfully continued. Mercury is of benefit not only in the primary and secondary manifestations, but also in the early stages of tertiary lesions. In the later stages of the tertiary period mercury and iodides are not of much benefit because the old gummatous and cicatrized tissues are little affected by these specifics. The treatment to be then followed is that given under Stricture of the Rectum.

Tuberculosis of the Anus and Rectum.—The source of inflammation in tuberculosis of the rectum is usually to be found in sputa which have been swallowed, or in contaminated food, such as milk from tuberculous cattle. In rare instances the infection may be brought in the blood-stream or introduced by scratching. The disease may manifest itself in superficial lesions of the mucous membrane or skin, or in chronic abscesses in the periproctal tissue, whence the poison has been carried by the lymph-channels. These abscesses are discussed under Periproctitis. The superficial lesions are of three sorts: The first and rarest is lupus of the skin about the anus, developing from a healed tuberculous fistula. In the second form, also rare, the disease manifests itself in papillary growths in the skin about the anus and the lining of the anal canal, which under the microscope are seen to be true tubercles. These lesions can easily be mistaken for pointed condylomata or papillary cancer. Papillary cancer will have, however, a hard base, which is wanting in tuberculosis. The third form in which tuberculosis manifests itself is in ulcers which may develop primarily in the skin and anal portion of the rectum, or which may follow abscesses and fistulas. The primary ulcer is rarely seen except in persons who are the subjects of advanced tuberculous processes elsewhere in the body. It has a tendency to destroy gradually in a circular manner the whole skin about the anus, and then the anal canal as far as the anocutaneous zone. There its progress stops, but it shows no tendency to heal. These patients suffer from pain, suppuration, diarrhœa, and partial incontinence, and usually die within a short time from general tuberculosis.

Tuberculous ulcers in the true rectum arise from the breaking down of tuberculous follicles and increase at the edges until they have been joined together. As the infectious material spreads in the submucosa along the lymph-channels, the tuberculous ulcer has its long diameter in the long axis of the bowel. These ulcers rarely extend above the lower part of the rectum. As they show little tendency to heal they are not likely to produce a stricture. They are easily recognized even macroscopically by their pale atonic base covered with soft granulations, with here and there a caseous tubercle, and by their margin, which presents semicircular defects due to the breaking down of the tubercles. The edge of the ulcer is usually undermined and of a bluish color. In the surrounding mucous membrane tuberculous nodules can here and there be seen. The secretion from the rectum is thin and watery. If the diagnosis cannot otherwise be made, a section should be removed for microscopical examination, or for inoculation of animals.

Treatment.—In addition to proper constitutional and local treatment, if the conditions are favorable, the diseased tissue should be removed. The ulcer may be cut out and the wound sewed, or it may be curetted and cauterized. If the ulceration is very extensive, local treatment is out of the question, and interference should be confined to relieving as far as possible the sufferings of the patient.

FISSURE OF THE ANUS.

A fissure of the anus is a small superficial ulcer situated in one of the folds of the skin about the anus, and usually characterized by symptoms of intense pain and contraction of the sphincter muscle. Such an ulcer may be due to the scratch of a hard fecal mass, and is often found associated with hemorrhoids, since mucous membrane stretched over the distended vessels is especially liable to injury. Furthermore, the congestion of the veins may soften the mucous membrane and make it less resistant. Ball says that the valves of Morgagni are apt to be caught and torn by the passage of hard feces, thus forming the starting-point of a fissure. At each movement of the bowels the injury may be extended. A fissure may also develop in women from cracks of the rectal mucous membrane, which are often produced by the passage of the child's head during labor. Other causes of fissure are eczema of the anus or an external injury the result perhaps of onanism. Gonorrhœa, soft chancre, and syphilis of the rectum may all be complicated by fissure.

Fissure is more common in adults, but is occasionally seen in children, and even in young infants. It should therefore be looked for whenever a young child screams with pain during defecation. The trouble is relatively more common in women than in men because they suffer more frequently from constipation.

On inspection by drawing the cutaneous folds apart the fissure will

appear as an elliptical ulcer with its long axis radiating from the anus. It is usually situated at the junction of the external skin and mucous membrane. The ulcer may or may not involve the whole thickness of the mucous membrane. It has a smooth base, grayish in color, rather dry, and which bleeds easily. The edges are slightly raised. The common situation of fissure is the posterior commissure.

Symptoms.—The characteristic symptom of fissure is the pain experienced during defecation when the fecal mass passes the anus. This pain may be very intense, and is often compared to that caused by a knife or a red-hot iron. The pain may produce unconsciousness or convulsions in children. Defecation may be followed by a few drops of blood, and a feeling of heat in the anus, associated with spasm of the sphincter muscle. These symptoms may subside in a few minutes, or they may last for hours. They may be confined to the region of the anus, or they may extend to the sacrum, thighs, and bladder. Retention of urine may be a result. It is not to be wondered at that such a painful affection is very depressing to a patient, and may lead to thoughts of suicide. Some patients, in order to avoid pain, postpone the act of defecation as long as possible; but the hardness of the fecal masses which is the result, simply adds to the suffering when they are finally evacuated. In severe cases the pains are produced not only by defecation, but also by the passage of gas, or by coughing, or by pressure in the sitting posture. In such cases reflex nervous symptoms may develop. Srehla observed in 5 children symptoms suggesting coxitis due to fissure ani only.

Examination.—A patient with an anal fissure should be examined with the utmost tenderness. It is usually impractical to introduce the finger into the rectum. External pressure with the finger at one point after another around the anus will usually reveal the site of the fissure by the contraction of the sphincter muscle which follows pressure on the tender spot. If the anal folds are drawn outward and apart, the fissure becomes visible. The finger in the vagina may serve to turn outward and expose a fissure placed anteriorly. In very sensitive individuals the examination should be preceded by a local or general anæsthetic. This will also allow a digital examination, which will frequently reveal some other trouble than the fissure, for example, hemorrhoids, polypi, strictures, etc.

Diagnosis.—The symptoms of fissure are so characteristic that the surgeon will generally make a diagnosis before he examines the patient.

The great pain caused by so small a lesion has been ascribed by Hilton to the exposure of the nerve-terminations in the base of the ulcer. Quénu and Hartmann, as a result of their microscopical investigations, deny this. They say that the ends of the nerves are involved in the inflammation, and that the special symptoms are due to this neuritis.

Prognosis.—The fissure may heal spontaneously; or, if untreated, it may remain for years.

Treatment.—Palliative measures may be employed in the case of a patient who refuses operation. Before defecation absorbent cotton soaked with a 10 per cent. solution of cocaine should be pressed lightly into the anus. When defecation is complete, an opium suppository should be inserted. Either cool or lukewarm sitz baths are often quieting. There should be a sufficient daily movement of the bowels produced by Carlsbad salt, the injection of 1 to 300 grammes of warm olive oil, or other mild measures. Some patients will be cured by this simple treatment. If it fails, the fissure may be touched with a stick of silver nitrate two or three times at intervals of two or three days.

If, in one or two weeks a cure has not been effected, an operation should be advised. The danger is slight and the success certain. It consists simply in the forcible dilatation of the sphincter muscle by the two index fingers, or the two thumbs should be inserted and drawn steadily apart in different directions. This operation requires a general anæsthetic. The fissure will usually be torn open by this procedure, which also cracks the mucous membrane in other places. A paresis of the sphincter ani will follow lasting from one to several weeks. The effusion of blood under the skin is often considerable. The patient should be kept in bed two or three days with cold wet dressings and morphine, if necessary. If this treatment fails, an incision may be made longitudinally through the fissure until the sound skin or mucous membrane is reached. This incision does not need to extend deeper than the whole thickness of the mucous membrane. It may be made with a knife, or better, with the sharp point of the thermocautery. A slender wick of iodoform gauze is laid in the wound, and as a result of suitable diet the bowels do not move for two or three days. The patient is then given castor oil and an enema, and the following day he may get up. The pain for the most part disappears at once, though until the wound is completely healed some slight pains may be noticed in sitting and at stool.

Deep incision of the fissure is rarely necessary. The originator of this operation planned to divide one or both sphincter muscles, and to tampon the wound with iodoform gauze. The bowels should be moved on the fourth day, after which the patient takes a sitz bath and submits to a redressing with boric acid and iodoform gauze. The patient leaves his bed in two weeks. The divided sphincter will ordinarily regain its function in from ten to fourteen days.

INFLAMMATIONS IN THE PERIPROCTAL CONNECTIVE TISSUE.

Etiology.—Inflammation and suppuration in the tissue about the rectum are the commonest lesions in this vicinity. This is due to the fact that the mucous membrane of the rectum is often injured by the passage of hard fecal matter, and is constantly exposed to infection. The part of the rectum which is especially subject to injuries of this character is the mucous membrane opposite the sphincter muscle. It

may be cracked by the extreme distention to which it is at times subjected, or it may be torn by hard substances, bits of bone, etc., which have been swallowed. At other times small particles of fecal matter catch and lie in the folds of the mucous membrane, especially in those of Morgagni, and lead to little ulcers. Attention has been drawn to the fact that most fistulas open internally in one of Morgagni's sinuses. Injuries of the membrane due to hot injections, wounds from fingernails or syringe-nozzles, etc., are not usually followed by suppuration. It is also to be noted that infection may take place without any visible break in the continuity of the mucous membrane, just as bacteria may enter the follicles of the tonsils and pass into the lymph-vessels.

Periproctal suppuration may develop secondarily to different diseases of the rectum which have lessened the protective power of its mucous membrane. Such diseases are catarrh, ulcers, and especially inflamed hemorrhoids. Periproctal suppuration may also develop from eczema, intertrigo, etc.; or it may extend from suppuration outside of the periproctal tissue or the prostate and urethra, or Cooper's or Bartholin's glands, from suppuration in Douglas's pouch or about the spine or some pelvic bone.

Pathological Anatomy.—The tissue-planes which govern extension of inflammation in this part of the body are:

1. The subcutaneous fat of the anal region is continuous with the submucous tissue of the anus and of the rectum.

FIG. 31.

Coronal section through the rectum.

2. The ischiorectal fossa is a pyramidal, three-sided space which is bounded anteriorly by the external sphincter and the levator ani muscle, externally by the ischium. Below, it passes without any fascial interruption into the subcutaneous fat of the buttocks. (Fig. 31.) The fat which fills the ischiorectal spaces right and left completely surrounds the external sphincter. Anteriorly and posteriorly there is a

thin connective-tissue septum which separates the right and left spaces. Anteriorly it extends well up to the symphysis pubes between the levator muscle and the trigonum (recessus pubicus).

3. The pelvirectal space is situated above the levator ani, and surrounds the rectum where it is not covered with peritoneum. It is limited anteriorly by the true fascia of the rectum, and externally by the perirectal fascia of the pelvis which covers the sacrum above and is sometimes called the prosacral fascia. This pelvirectal space is separated from the ischiorectal space by the levator muscle. It is continuous above with the retroperitoneal tissue.

Suppuration in the periproctal connective tissue may be either diffuse or somewhat circumscribed.

Diffuse suppuration of the septic type is seen for the most part only after extensive wounds or operations. One or two days after the injury the wound and the tissue about it are distended with seropurulent fluid and soon become gangrenous. Such a condition is most dangerous if it affects the pelvirectal space, since it may readily extend upward into the retroperitoneal space, or forward into the abdominal walls. Portions of the peritoneum and intestines may become gangrenous, or the trouble may extend to the scrotum, penis, and buttocks, and give rise to extensive destruction of tissue. Death usually follows in from two to ten days. In such fulminating cases staphylococci and streptococci, and possibly other bacteria are found.

A diffuse inflammation associated with the formation of gas, and running a somewhat milder course than the preceding, may be produced by *Bacterium coli*. The temperature is only slightly elevated, and aside from a mild œdema in the subcutaneous and intermuscular cell-tissue there is nothing to be observed locally. Gradually there follows emphysema of the tissue with development of small abscesses and necrosis of the overlying skin. There is seldom metastasis. Such patients become restless and somnolent, and usually die within a few weeks.

The third form of diffuse inflammation—or, rather, gangrene—develops either spontaneously or as the result of some gross injury; for example, injection of fluid into the periproctal connective tissue instead of into the rectum. Such an inflammation may begin in the skin and extend upward, and is marked from the first by gangrene, often extending to the scrotum, penis, or to the deeper tissues. Sometimes multiple incisions will save the patient.

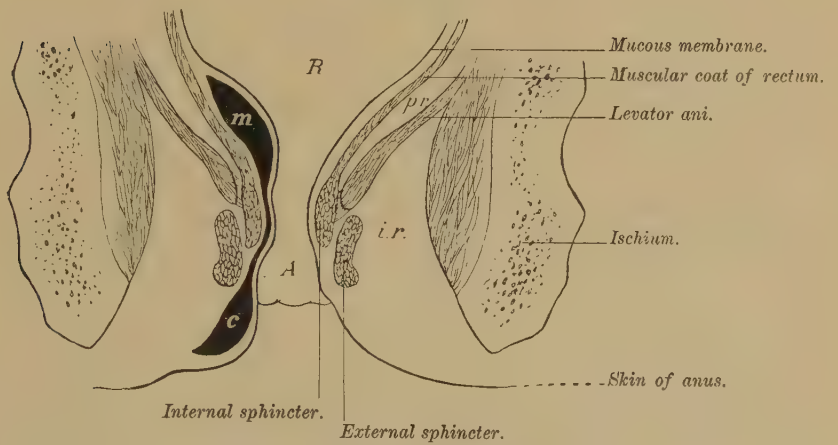
Circumscribed periproctal inflammations and abscesses may be developed according to their situation:

1. Superficial abscesses develop beneath the skin at the margin of the anus and present themselves beneath the sphincter. They may extend outward to the ischium and involve the ischiorectal space; or they may extend upward into the submucous tissue of the anal portion. (Fig. 32.)

Submucous abscesses are situated just above the anus, and may

extend downward into the subcutaneous tissue or upward into the submucous tissue of the rectum. Such an abscess may rupture externally through the skin, but usually it breaks through the mucous membrane, especially in one of the sinuses of Morgagni, or still higher up, thus forming a fistula. As the pus accumulates it may, instead of breaking through into the rectum, work its way between the internal and external sphincter into the ischiorectal fascia. Such an abscess may run an acute or a chronic course. In tuberculous patients a chronic abscess is the rule, and it may develop without pain, and indeed without the patient being aware of its presence.

FIG. 32.



R, rectum; *A*, anus; *m-c*, location of pus in a mucocutaneous abscess; *pr*, pelvirectal space; *ir*, ischiorectal space.

2. Abscesses in the ischiorectal fascia are rarer than the superficial abscesses in the proportion of 1 to 5. They may develop secondary to superficial abscesses or as the direct result of infection from the rectum. An acute abscess of this character usually produces a chill and high fever, with intense local pain, tenesmus, disturbance of micturition, etc. On account of its deep situation the diagnosis in an early stage may not be easy. The palpating finger will notice the painful resistance on the affected side. If such an abscess is not opened early, it may rupture in several directions, of which the most favorable is through the skin or into the rectum between the external and internal sphincter. The pus may burrow in the ischiorectal space, and then, passing a slight barrier in the median line, extend into the opposite ischiorectal space, the so-called dissecting phlegmon. A still more serious condition is produced when the pus breaks into the pelvirectal space and extends upward into the retroperitoneal connective tissue.

If the pus in an ischiorectal abscess is not evacuated sufficiently early and completely, the patient may develop septic or pyæmic symptoms, and even die.

While the tuberculous ischiorectal abscess usually progresses slowly and without marked symptoms, it may if left to itself rupture in various ways, and by reason of mucous infection give rise to acute symptoms.

3. A pelvirectal abscess may develop from ulcer or stricture of the mucous membrane of the rectum, or secondarily by the rupture of an abscess in the vicinity; but in more than half the cases it is due to suppurative or tuberculous inflammation of the prostate. In rare instances it comes from suppuration of the spine or some pelvic bone. On account of its deep situation diagnosis is difficult, but it may easily be made if a thorough digital examination is carried out. The finger passed above the sphincter will feel an inflammatory tumor pushing the rectal mucous membrane into the lumen. Acute abscess of the pelvirectal space usually produces severe septic symptoms and exposes the patient to the danger of extension in the retroperitoneal connective tissue.

An abscess of this character, whether acute or chronic, may break into the lumen of intestine or into the ischiorectal space, or through the ischiorectal space it may reach the external skin. Those which start from the prostate may work their way to the perineum or into the scrotum, or may rupture into the urethra.

Treatment.—The treatment of a periproctal abscess is purely surgical, and consists in early evacuation of the pus in order to prevent its extension. A superficial abscess whether subcutaneous or submucous should be exposed by an incision radiating from the anus and as long as the cavity of the abscess. An ischiorectal abscess should be opened by an incision parallel to the sphincter muscle. If it has broken through the exterior raphe, a radiating incision in the posterior median line should be made dividing the external sphincter. From this incision both ischiorectal spaces should be opened by cuts parallel to the sphincter. In this manner multiple divisions of the sphincter will be avoided. A periproctal abscess should never be opened into the rectum no matter how tempting its presentation, since the abscess cavity will invariably soil with fecal matter and healing be delayed; it should be drained from the skin. If it starts from the prostate, a cross-cut should be made in front of the anus. This may be extended upward between the rectum and the urethra by blunt dissection. The introduction of a sound or of a finger in the rectum will keep the surgeon from injuring these organs. When the levator ani is reached, the finger should be worked through between its two heads until it touches the lower border of the prostate and passes into the abscess cavity. Such a wound should be drained with a rubber tube and iodoform gauze.

FISTULA IN ANO.

Etiology.—Periproctal abscesses if left to heal of themselves, only exceptionally do so. The abscess cavity grows smaller and smaller, and finally becomes a mere passage lined with granulations and surrounded by dense scar-tissue. When no further changes in the direction of healing take place, it is called a fistula. From this it is understood that a fistula in ano always develops from a periproctal abscess; and like that, it is a very common lesion. Men suffer from it oftener than women. While those in middle life are most frequently affected, the aged and young children are not spared. Sometimes the infection is a simple pyogenic one; sometimes it is tubercular. If a patient with tuberculosis of the lungs swallows sputa containing bacilli, these may find an opportunity for development in the rectum. On the other hand, the anal fistula may be the first symptom of tuberculosis. In this case the bacilli have probably been introduced with food. Statistics show that from 10 to 14 per cent. of those who suffer with anal fistulas have tuberculosis of the lungs. It goes without saying that a phthisical patient may have an non-tuberculous fistula. The nature of the infection can be determined by an examination of the lining granulations. or of the pus which flows from the fistula. The bacilli in such cases are few and far between, and the microscopical examination is therefore less conclusive than the inoculation of an animal. By following the latter method Hartmann found that 50 per cent. of his cases were of a tuberculous character. On the other hand, it has been estimated that 5 per cent. of all phthisical patients suffer from anal fistulas. In rare instances an anal fistula may be due to diabetes or syphilis. It has been shown that many long-standing fistulas which open into a sinus of Morgagni are clothed at least in their inner portion with epithelial cells. (Tavel-Meisel.)

Pathological Anatomy.—Fistulas in ano may be classified according to the position of the fistulous orifices. If the passage opens into the rectum as well as through the skin, it is called a complete fistula, with a cutaneous or outer, and a mucous or inner orifice. (Fig. 33, B.) If the passage has but one opening and leads into the perirectal tissue, it is called an incomplete fistula—internal if its opening is through the mucous membrane, and external if it is through the skin. (Figs. 33, A, and 34, D.) If there are numerous passages and openings, the fistula is spoken of as complex.

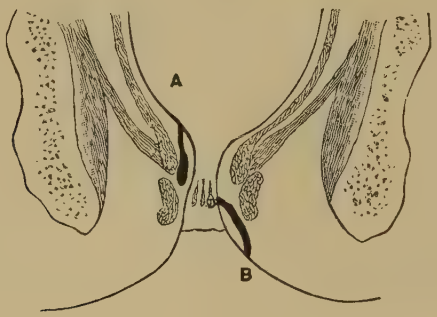
Fistulas may also be classified according to their relation to the anatomical parts of the rectum and its neighborhood, especially to the muscles. Three varieties are to be mentioned:

Subcutaneo-submucous fistulas (Fig. 33, A and B) are the commonest variety. They extend through the subcutaneous or submucous tissue beneath or inside of the sphincter—that is to say, between it and the skin or the mucous membrane.

Ischiorectal fistulas are about five times rarer than the preceding.

They extend from the external skin into the ischiorectal space outside of the sphincter, and end there blindly. If a passage also extends to the rectum, it usually does so between the internal and external phincters (Fig. 34, c), or more rarely above the internal sphincter.

Fig. 33.



Pelvirectal fistulas (Fig. 34, d), developing from abscesses of the same name, are rare. For the most part they occur in patients with prostatic disease, and are usually situated in front of the rectum.

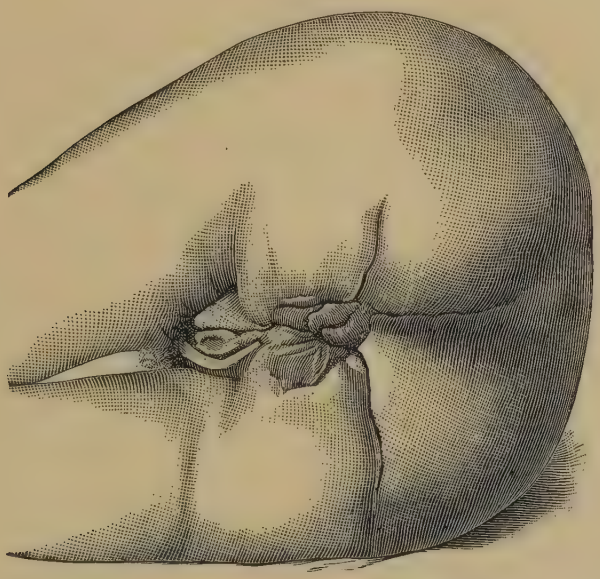
Fig. 34.

The internal orifice of a subcutaneo-submucous fistula lies almost always just above the anocutaneous line, usually in one of the sinuses of Morgagni. In the case of an ischiorectal fistula the opening lies between the internal and external sphincters—that is to say, from 1 to 1.5 cm. (0.39 to 0.6 inch) above the anus, rarely above the internal sphincter (1.3 per cent.). If the mucous membrane is undermined above the internal orifice and a second time perforated, the fistula is spoken of as a bimucous one. The internal opening of a tuberculous fistula is relatively large and is frequently an ulcer. The external orifice in the case of a subcutaneo-submucous fistula may be

close to the anus, often hidden posteriorly in an anal fold. The external orifice of an ischiorectal fistula is further removed from the anus and usually situated to the side, seldom behind. The internal orifice may be retracted, or it may be situated in a wart-like elevation of the skin. In healthy persons it is narrow; in tuberculous subjects it is wider and often surrounded by a small ulcer of characteristic type. (Page 103.) The fistulous passage may be a direct one, or tortuous as a result of cicatricial contraction.

Complex fistulas are usually found in the external skin rather than in the mucous membrane. If a fistula exists for a long time, closure of its orifices, obstruction of its passage by cicatricial contraction, or new infection, may form abscesses, which in turn lead to new passages and

FIG. 35.



Cicatrices resulting from tuberculous fistulas around the anus. (Quénu and Hartmann.)

orifices. It is of practical importance to divide such complex fistulas into those which are lateral—that is, confined to one side—and those which are commissural, extending beyond the median line. The latter variety of fistula usually occurs behind the anus, developing from the dissecting phlegmon of the ischiorectal space.

The question why an anal fistula does not heal of itself is an interesting one. Incomplete internal and complete fistulas are evidently prevented from healing by the passage into them of small particles of fecal matter. If the fistulous passage is tortuous, the secretion escapes with difficulty; hence healing is prevented. A further obstacle to healing may be found in the constant disturbance of the walls produced

by the contraction of the muscles in the neighborhood. In the case of tuberculous and syphilitic fistulas the disease itself may prevent spontaneous cure of the fistula.

Symptoms.—Incomplete external fistulas give only such symptoms as moisture, itching, irritation of the skin, slight annoyance during defecation, etc. Complete fistulas are more troublesome. A certain amount of pus mixed with mucus and fecal matter is discharged from the external orifice, moistening and irritating the skin and soiling the clothing. Often gas passes involuntarily. Pain and tenesmus may also be present. An incomplete internal fistula is marked by an indefinite pain within the rectum, which is increased at defecation. Pus and blood are often passed with the stools. If there is retention of secretion and new abscesses form, the symptoms of acute suppuration become prominent.

Diagnosis.—If an external orifice exists, the diagnosis is easily made with the probe if the folds of skin about the anus are smoothed out so as to permit a good view. Sometimes pressure of the finger in the anus will cause a drop of pus to exude, thus revealing the orifice. An internal orifice can be made out by digital examination. It is usually marked by a little papilla from which leads a hard core. If there is also an external opening, a probe may be passed into it and gently directed through the internal orifice until it touches the finger. Incomplete internal fistulas are diagnosticated with difficulty. If the examining finger fails to recognize either the hard core or the papilla in the mucous membrane, the patient should be anæsthetized and examined with a speculum. In the examination of a complex fistula a knowledge of the anatomical relations and the nature of the process from which it is developed will materially assist the surgeon in locating its various channels.

Prognosis.—Spontaneous cure results only in case of an incomplete fistula into which no fecal matter can pass. For all others the only treatment worth considering is operative, and this should be undertaken early before a simple fistula has undergone secondary inflammatory changes. The possibility of cure depends upon circumstances. Cure can be obtained in practically all non-tuberculous fistulas, and in the majority of tuberculous fistulas if the general condition of the patient is good, while an improvement or prevention of secondary suppuration may be attained in many other cases.

Treatment.—The only rational treatment of fistula in ano is operative. The principle of operation rests upon the division of tissue between the fistula and the anal canal so that the fistulous passage shall be converted into an open gutter. Since retention of pus is then no longer possible this gutter will gradually heal from the bottom until it becomes superficial and finally completely cicatrizes. For two days before operation the patient's bowels should be emptied by castor oil and enemata, the last of which should be given not less than five hours previous to operation. The patient should be placed in the lithotomy

position, or else upon the affected side. In simple cases local anæsthesia may suffice. When the patient is anæsthetized, a flexible probe is passed into the fistula in order to reach the anal canal. If this attempt does not succeed, the forefinger of the left hand is passed into the anus and searches for the hard core leading to the internal orifice, in order to guide the probe to it. One should avoid making a false passage with the probe. If, however, the end of the probe is separated from the finger by only the mucous membrane, it is permissible to push it through against the finger. The finger within the anus is then crooked and withdrawn so as to bring the internal end of the probe outside of the anus. The tissue between the fistula and the anus is then divided upon the probe by either a knife or a thermocautery. By means of the speculum and sharp hooks the mucous membrane of the anal canal should be drawn outward so that the wound may be thoroughly inspected and no side passages neglected. Unhealthy granulations should be scraped away with a sharp spoon. When bleeding has been checked, a rubber tube 1 cm. (0.4 inch) in diameter and 8 cm. (3.2 inches) long, wrapped with iodoform gauze, is passed into the anal canal in order to facilitate the escape of gas. The wound is carefully packed with iodoform gauze, and the field of operation covered with a thick pad of gauze and cotton which is held in place by a T bandage. The administration of opium to prevent a movement of the bowels is a mistake. If the patient has been carefully prepared, and is kept in bed upon a light diet, the bowels do not incline to move before the fourth day. Morphine may be required in the first few hours after operation on account of the pain. The first defecation is apt to be painful. Immediately after it the patient should sit in a tub of hot water, and then the wound should be washed out with a mild antiseptic and again tamponed with iodoform gauze. From this time on there should be a daily defecation and dressing of the wound. The patient should leave his bed in eight to ten days, and go about after two weeks.

Such is the plan of operation for complete and incomplete external fistulas. In incomplete internal fistula the patient is thoroughly narcotized and the orifice of the fistula is sought for by means of the speculum. When found, a sharply bent probe is passed into it and the fistula is opened clear to the skin.

The question arises, how far the function of defecation is affected by the possible division of the sphincter muscles. In subcutaneo-submucous fistula the anal skin and mucous membrane are alone divided. In ischiorectal and pelvirectal fistulas one or both sphincters lie between the fistulous passage and the anal canal; it is therefore important to know whether incontinence of feces will follow their division. If only the external sphincter is involved and it is cut in a single place directly across its fibres, loss of sphincteric action of the anus need not be feared. If the external sphincter is cut obliquely or in two or more places, or if both sphincters are divided, incontinence may follow, but such is not always the case.

If an ischiorectal fistula reaches the bowel between the internal and external sphincters, and also has a blind passage upward, it may be treated by dividing both sphincters so as to open the whole passage into the rectum. Such a radical procedure is not, however, necessary. If the tissue between the internal and external orifices, including the external sphincter, is divided, and the blind passage is curetted and tamponed with gauze, it will fill with granulations and cicatrize. If the ischiorectal fistula opens above the internal sphincter, both sphincters must be divided to effect a cure; fortunately such a condition rarely exists. It does exist, however, with a pelvirectal fistula.

To cure a complex fistula with numerous passages, it is usually necessary to split open and expose them all. The operator should be careful to avoid multiple division of the sphincter. Fortunately, in these cases there is usually only a single internal opening placed laterally. The complicating passages are to be opened by a cut parallel to the fibres of the sphincter, while a single cut across the fibres of the sphincter is to be made to the internal opening. A similar plan should be followed in case of a commissural fistula. A circular cut through the skin should lay open the subcutaneous passage and enable the operator to find the passage which leads most directly to the rectum. This opening, which is usually placed posteriorly, should be exposed by a single radial cut into the bowel.

In the case of tuberculous fistula it is especially important to remove all tuberculous granulations. Undermined, thin, cutaneous edges should be clipped away with the scissors, and the passages thoroughly curetted and then cauterized with the thermocautery; or, if circumstances permit, the whole fistulous passage may be excised and primary union attempted.

The time required for healing after these operations is rather long. Such a wound tamponed with iodoform gauze will rarely heal in less than six weeks, and oftener the requisite time is from two to six months. Recovery is particularly slow if the fistula is tuberculous, such sinuses often refusing to heal completely. Granulations may be stimulated by silver nitrate, tincture of iodine, and other remedies, and sometimes the wound is favorably influenced by curetting. If the hair about the anus is abundant, it should be regularly shaved, because it interferes with the healing of the wound.

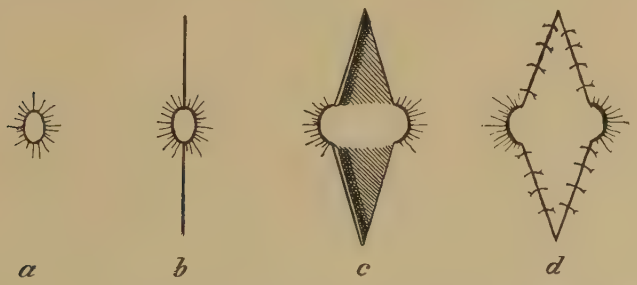
It has been proposed to shorten this long period of recovery by excising the fistula completely and suturing the resulting wound in layers with catgut in a manner similar to the restoration of the perineum. If this operation is performed, the bowels should be thoroughly emptied before operation and constipation secured for eight or ten days after the operation by a rigid diet and opium. By this method success can often be attained. It is by far the best treatment for fistulas lined with epithelium. The chief points are a thorough preparation of the patient, cleanliness in the operation, and a careful cauterization of the wound-surfaces so that no dead spaces shall remain. This method is only adapted to certain cases.

Division of the tissue between the fistula and the anal canal by means of a ligature passed through the fistula and knotted, was a method of treatment practised by Hippocrates and by many since his time. At present it is only of historical value. If the patient will not submit to a cutting operation, it is better to divide the tissue by means of the galvanocautery, the loop of which can be passed through the fistula by means of a threaded probe.

STRICTURE OF THE ANUS.

Etiology.—Stricture of the rectum may be confined to the cutaneous zone of the anal portion—that is, to the anus itself. This rather rare

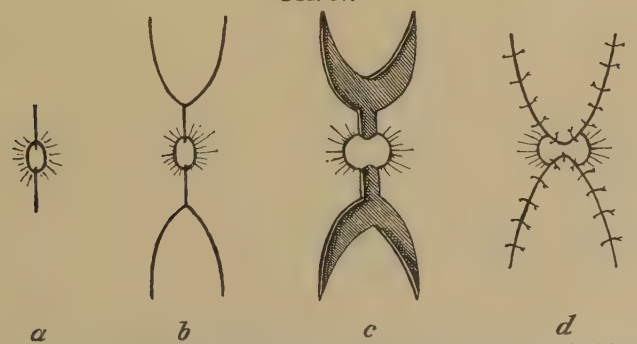
FIG. 36.



Operation for anal stricture: *a*, stricture; *b*, incision through skin; *c*, incision through mucous membrane; *d*, suture of skin and membrane.

condition may be due to cicatricial contraction following ulcerations or gangrenous processes; or it may be due to certain operations upon the anus, such as cauterization, or Whitehead's operation for hemorrhoids,

FIG. 37.



Flap operation for anal stricture: *a*, stricture; *b*, incision through skin; *c*, incision through mucous membrane; *d*, suture of skin and membrane.

or an operation for fistula in which too much skin and mucous membrane has been taken away. If the stricture of the anus is tight, the opening may be so small that a probe can scarcely be introduced, and evacuation of fecal matter takes place with difficulty.

Treatment.—Relief of this condition may be attempted by gradual dilatation with bougies. A stricture can usually be dilated in this manner, but is apt to recur. Operation gives a better prognosis. The incision is made through the stricture forward and backward from the perineum to the coccyx. (Fig. 36, *b*.) The mucous membrane is then separated until it can be easily sewed to the edges of the skin. (Fig. 36, *d*.) The success of this method depends upon the possibility of freeing the mucous membrane. If the stricture is so extensive that this is not possible, the skin may be utilized to supply the lack by cutting from it two tongue-shaped flaps. This procedure is similar to Dieffenbach's plastic operation upon the mouth. The stenosis is first divided in front and behind, and the skin-flaps marked out and loosened from the underlying tissue. (Fig. 37, *b* and *c*.) These flaps are then stitched in the divided anus. It is especially important that there be no tension upon them.

STRICTURE OF THE RECTUM PROPER.

Stricture of the rectum proper is much commoner than stricture of the anus. It may be due to changes within the rectum itself, or to changes in its neighborhood. Benign tumors lying outside of the rectum, for example, myomata of the uterus, may by compression of the rectum interfere with defecation, but they never actually prevent it. Malignant tumors, such as carcinoma of the uterus or ovaries, by growing into the rectum may produce a stenosis or even complete obstruction. Cicatricial contraction, which may follow inflammatory processes, especially those associated with the female pelvic organs, may, by compressing the rectum, give rise to chronic obstruction. The finger passed into the rectum feels a hard mass at about the level of Douglas's pouch which presses the rectum backward and is firmly attached to the sacrum. Finally, tuberculosis, peritonitis, and appendicitis, with secondary abscess formation in Douglas's pouch, may narrow the lumen of the rectum.

The changes in the rectum itself which give rise to stenosis may be divided into those which do not affect the mucous membrane, and those in which the mucous membrane is involved. Of the first class there is to be mentioned inflammation which develops in false diverticula from the long-continued presence of hard fecal masses. Ulceration, perforation, inflammation, and suppuration beneath the peritoneum, or in the connective tissue of the mesentery, may follow. In a long-standing process of this character there is a good deal of connective-tissue formation, which contracts and changes the lumen of the bowel to a hard small ring. From 5 to 20 cm. (2 to 8 inches) of the bowel may be affected in this manner. The mucous membrane is not attacked by this process and lies in the narrow lumen of the bowel in numerous folds.

Stricture of the rectum, however, usually arises from some cause which involves the mucous membrane as well as the outer coats of the

bowel. Cancer is by far the commonest cause, although cicatrices following injuries due to foreign bodies, or a difficult labor, or burns with hot water, may give rise to stenosis. Such a stricture may be like a string tied around the bowel, or it may be more extensive, like a narrow tube. It may involve the whole circumference of the bowel or only a portion of it. Gangrene of the mucous membrane of the rectum, resulting from injury of the superior hemorrhoidal arteries during pelvic operations, has been mentioned as a cause of stricture.

A common stricture of the rectum, and one which may be regarded as typical, develops from chronic inflammation. This was formerly considered to be syphilitic, a name which is still frequently used in this connection. The stricture may, however, develop in the course of a simple chronic proctitis or as a result of gonorrhœa, a variety of inflammation which is now known to be quite common in the female rectum. It may develop years after the acute attack of gonorrhœa, as does stricture of the urethra. Tertiary syphilis may also cause stricture of the rectum. This has been disputed because such strictures are not affected by antisyphilitic treatment. But this is not to be wondered at, since when the patients present themselves for treatment the specific products have already disappeared and only inflammatory and cicatricial processes remain. Microscopical examination of the tissue supports the view that rectal stricture is often caused by syphilis. Dysentery, if sufficiently severe to cause extensive ulceration of the rectum, may bring about stricture.

Pathology.—The stricture is usually situated low down in the rectum, at the juncture of the anal portion with the true rectum. It is usually single, and of a length varying from 1 to 4 cm. (0.4 to 1.5 inches); although it may extend throughout the whole rectum, and even into the sigmoid flexure. The changes in the wall of the rectum in the early stages vary according to the character of the inflammation. In the later stages the condition is essentially the same whatever may have been the cause of the inflammation. The rectum throughout the extent of the sphincter is transformed into a more or less stiff narrow tube. Such mucous membrane as remains is in a condition of chronic inflammation, usually of a proliferative type. The mucous membrane may be wanting. The mucous membrane below the stricture is usually chronically inflamed. There are often fissures and ulcers of the anus. The submucous tissue is hard. The muscular coat is filled with connective tissue; and if the process has gone on a long time, the muscular fibres are atrophied. The tissue of the rectum is often involved in the cicatrix, and consequently suffers from abscesses and fistulas. The latter if present usually open below the rectal stricture. There may be perforation into the bladder, vagina, pouch of Douglas, etc.

Typical stricture of the rectum occurs about four times as frequently in women as in men, a result presumably due to the ease with which gonorrhœa and syphilis may be transplanted from the vulva to the rectum.

Symptoms.—Every stricture is accompanied by the symptoms of chronic rectal catarrh. There is an abundant secretion of mucus and pus, which may be mixed with blood and bits of mucous membrane. There is frequent desire for stool, especially on waking from sleep, and often only mucus and pus can be evacuated. The stenosis of the rectum interferes seriously with defecation. The stool may appear normal except for the mucus and pus which accompany it. If the stool is formed, it may be ribbon-like or made up of lumps. In the former case the stricture is said to be low down, and in the latter higher up. It is worth remembering that patients without stricture may produce stools of both types. Moreover, if the stricture is situated high up, fecal matter may pass it and form in the ampulla below it perfectly normal stools. A more reliable symptom is the more or less constant diarrhœa. The fecal masses collecting above the stricture are mixed with mucus and pus, forming a thin fluid which continually dribbles past the stricture and is evacuated in small quantities. If the stricture is situated at the sphincter, it may give rise to incontinence of feces. Often constipation and diarrhœa alternate.

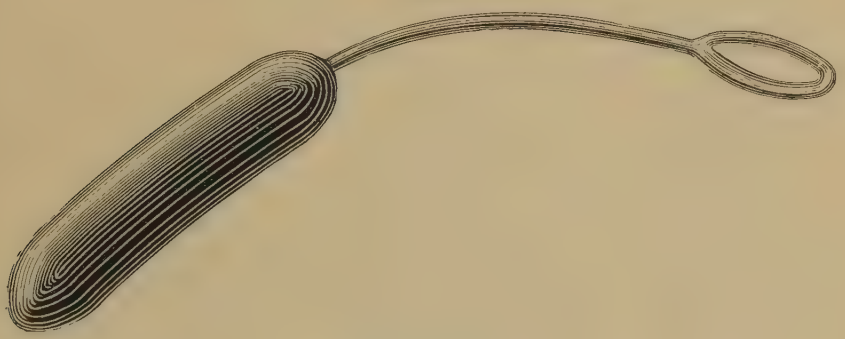
Defecation usually causes pain at the site of stricture and in the sacrum. Sometimes there is recurring and marked colic in the large intestine on account of the increased peristaltic action set up by the fecal masses. The absorption of poisonous fecal products may disturb the patient's appetite, produce nausea, pains in the head and stomach, fever, etc. As a result the patient becomes almost as cachectic as one who has cancer. A patient may live for years with stricture of the rectum, or he may speedily die on account of such complications as tuberculosis of the lungs, or ileus, or perirectal abscesses with perforation and amyloid degeneration.

Diagnosis.—If the stricture is situated low down, the diagnosis can easily be made by digital examination. If the stricture is high up, it is best reached with the patient in the standing posture, or bimanually when the patient is anæsthetized. If a diagnosis cannot be made without bougies, an examination should be made with them. For this purpose one needs a special instrument. Soft bougies bend so readily that failure to pass them does not necessarily indicate a stricture. It is more significant when the instrument is withdrawn with difficulty. The best instrument for examination is a sound with a smooth tip such as is used for stricture of the œsophagus. The instrument should be passed several times in order to ascertain accurately the site and calibre of the stricture. If the stricture is a very narrow one, the amount of water which the rectum will contain will give some indication of its location.

Treatment.—In stricture due to syphilis suitable internal medication should be given. Such treatment is of service, however, only in the early stages of the disease, since neither mercury nor iodides produce any beneficial effect upon long-standing strictures. Locally one may employ such measures as are beneficial in the treatment of chronic

catarrh and ulcers of the rectum. The treatment of the stricture itself may be either mechanical or operative. The former consists of a gradual dilatation of the stricture by means of bougies. The instruments usually employed are made of metal or vulcanized rubber, so that they may be sterilized by boiling. They should be of all sizes up to 2 cm. (0.8 inch) in diameter, and curved so as to correspond to the curve of the sacrum. (Fig. 38.) Half an hour before the introduction of the instrument the rectum should be cleansed by irrigation. The instrument should be well lubricated and guided in its introduction by the finger, care being taken, especially in introducing the smaller sizes, not to perforate the rectum at some weakened spot. In a few minutes the next larger size is introduced, and so on until a size is reached which fills the lumen of the stricture without pain; this should remain in place for ten minutes or longer. Such treatment

FIG. 38.



Credé's rectal bougie.

should be repeated every two or three days. If increased pain, suppuration, or fever follows the treatment, a longer interval should intervene before it is resumed. Some writers advocate the cocainization of the strictured portion by means of a swab of cotton.

If the dilatations proceed very slowly, shallow cuts may be made in the stricture by means of a blunt-pointed knife. The knife may be guided by a sense of touch, or a general anæsthetic may be given and the cuts made under the guidance of the eye. These cuts should be shallow in order to avoid hemorrhage and infection. If the patient presents symptoms of absorption of poisonous material which has collected above the stricture, a soft rubber catheter should be introduced and the retained fecal matters washed away. Kummel has succeeded in dilating strictures above the reach of the finger by means of soft rubber bougies. These may either be solid or hollow, and in the latter case they may be filled with shot or quicksilver after their introduction in order to stretch the stricture.

Such treatment, faithfully carried out, will usually succeed in dilating a stricture sufficiently to relieve the patient of the chief symp-

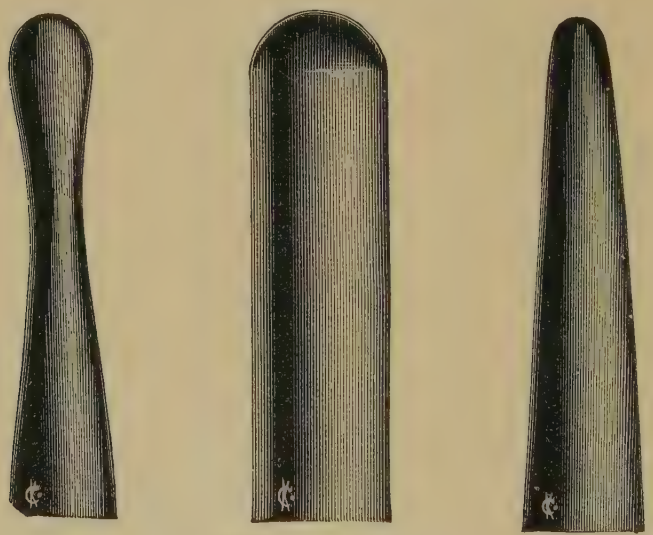
toms, but it will seldom result in cure, especially after the disease has progressed until the mucous membrane has been permanently injured. Ulceration produces constantly a tendency toward new contraction, so that the patient is obliged to resort to treatment every week or two throughout his life.

Forcible dilatation, by which the stricture is overcome by means of powerful instruments, is a dangerous treatment and ought never to be employed.

The various operative procedures which have been followed successfully are as follows:

Internal proctotomy is an operation by which large shallow incisions are made to facilitate dilatation; or the stricture may be divided and sutured transversely (Péan's rectoplastic). This operation is indicated in the case of movable, valvular, low-lying strictures, especially of the congenital type. If it is performed in the case of a cicatricial stricture, the trouble almost invariably recurs.

FIG. 39.



Dilating bougies for rectum.

External or linear proctotomy is carried out as follows: An incision is made in the median line from the anus to the sacrum and the coccyx, and if necessary a portion of the sacrum, are excised. The finger or a sound is introduced into the rectum, and the rectum is divided longitudinally from above the stricture down to the anus. There is profuse hemorrhage, which can be checked by compresses. The wound has to be dressed with iodoform gauze, and will not heal for several months. This operation gives free vent to the feces and pus, since it opens not only the bowel above the stricture, but also any perirectal

abscesses which may be present. Moreover, in the healing process the cut edges of the rectum are drawn toward the skin so that the lumen of the bowel is increased. In spite of this it will often be found necessary to resume dilatation by bougies before the wound is completely healed. The statistics of 37 cases (Lachowski and Sonnenburg) show that 15 per cent. of the patients died from operation, and as many more in the first year from cachexia and phthisis. Most of the survivors were troubled with recurrence within a year.

The stricture may be extirpated, care being taken to preserve the sphincter. If the stricture is located in the anal portion, an attempt should be made after the posterior proctotomy to dissect the cicatricial masses from within the sphincter muscles. If the healthy mucous membrane is loosened from above, it may be brought down through the sphincter and stitched to the skin. If the stricture lies above the sphincter, the affected portion of the rectum may be removed in accordance with the directions given under Carcinoma of the Rectum. Extirpation of the rectum on account of benign stricture is usually more difficult than the extirpation of a carcinomatous rectum, since the surrounding inflammation makes it impossible to follow the tissue-planes without constant cutting. For the same reason hemorrhage is very troublesome. In spite of this Schede has reported 17 operations without a death, and Mikulicz 6 cases with only 1 death. According to recent statistics, one-half of 10 cases were free from recurrence for periods varying from one to six years. Most of them were free from incontinence of feces. Wegner reports late results in 5 cases. The general condition was improved, but there were more or less local recurrence and some incontinence.

Inguinal colostomy (Vol. IV., page 456), by allowing the feces to pass from the sigmoid flexure, will free the patient from the symptoms due to obstruction. Furthermore, since the diseased rectum will be relieved of the constant irritation of fecal masses, it is in a more favorable condition for healing and for local treatment. These considerations may overweigh the disadvantages of an artificial anus.

It is sometimes possible to make an anastomosis between the bowel above and below the stricture, and thus to relieve the patient of the obstruction while retaining the action of the sphincter muscle. This operation has been named sigmoideoproctostomy. Bacon, who first proposed this operation in 1893, thought it was only adapted to cases in which the stricture was above Douglas's fold. It is carried out by laparotomy with the aid of the Murphy button. One-half of the button is inserted in the sigmoid and the other passed up through the anus until its stem emerges through the slit in the rectum. After the evacuation of the button in one or two weeks the opening from the sacrum to the rectum can be enlarged by clamps passed into the anus. Bacon reported 12 patients cured in this manner.

Rotter and Kelly have adapted this principle to strictures which lie

only 2 or 3 cm. (0.8 to 1.2 inches) above the anal portion by dividing the bowel above the stricture and inserting the cut end of the sigmoid into a slit made in the rectum below, or even through the stricture. In order to do this it is necessary to make a cross-cut in the perineum and split the septum between the rectum and the vagina, or between the rectum and the urethra, as the case may be, and to continue the dissection until Douglas's pouch is reached. The upper cut end of the rectum is closed by a suture. This plan may be followed even though the disease extends into the descending colon; and if the anal portion is extensively affected, it may be dissected out of the sphincter muscles and the free end of the colon inserted to take its place.

Choice of Operation.—Mechanical dilatation should be tried in the early stage of the disease as long as the mucous membrane shows no gross defects and the rectal wall is still distensible to a certain degree. The stricture must also lie within easy reach of bougies. This method of treatment is also applicable in the case of any patient who flatly refuses operation. If the mucous membrane is extensively diseased or is wanting throughout large areas, mechanical dilatation is unsatisfactory. But even under such circumstances the narrowed rectum may be kept for weeks or months sufficiently dilated to prevent the collection of feces above the stricture. Under such circumstances if treatment is given up contraction will forthwith reappear. Extirpation is therefore advisable, especially if it can be carried out without permanent injury of the sphincter. Unfortunately, the results of this operation are far from satisfactory, less than half of the patients so operated upon having been permanently benefited. Not all cases are suitable for extirpation. The presence of perirectal suppuration not only renders extirpation extremely difficult, but also adds greatly to the risk on account of the infection of so extensive a raw surface. External proctotomy is unsatisfactory under these conditions. Sigmoideoproctostomy is to be preferred. By this method the diseased tissue is left in place, and may give rise to prolonged or even permanent suppuration. Sometimes, however, it results in a perfect cure. If perirectal suppuration accompanies a high stricture, or the patient is not in condition to undergo a prolonged difficult operation, colostomy is indicated. The formation of an artificial anus is also indicated when recurrence follows resection, when there are symptoms of ileus, when the stricture is in the sigmoid colon, or the sigmoid mesocolon is much contracted. The hope that the rectum when relieved of irritation by colostomy will heal and recover its function, so that the artificial anus may later be closed, has unfortunately seldom been realized.

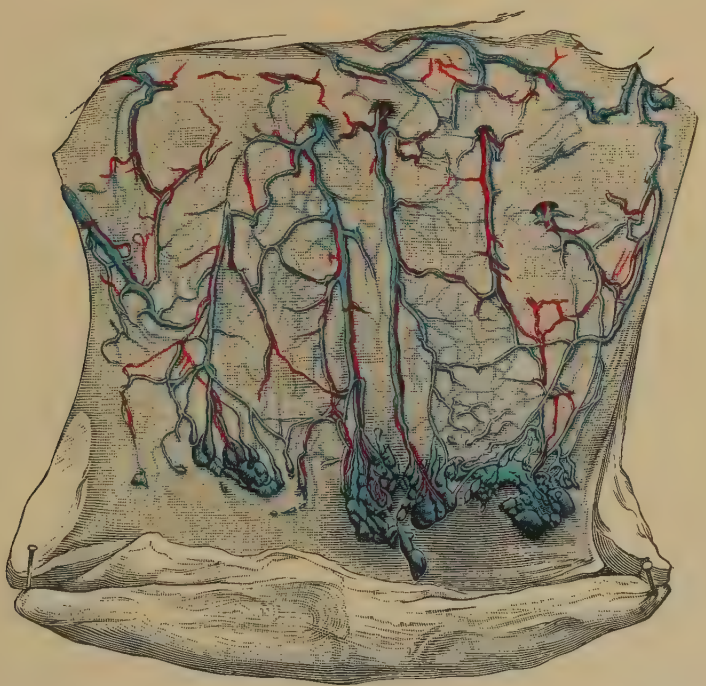
HEMORRHOIDS.

The name hemorrhoids has been given to a condition characterized by excessive development with increase in calibre of the veins of the rectum. Hemorrhoids may be external or internal.

External hemorrhoids develop in the branches of the inferior hemorrhoidal plexus, the blood from which passes into the pudic vein. This plexus lies subcutaneously, and extends from the anus upward to the anocutaneous line, which is at the level of the lower margin of the internal sphincter.

Internal hemorrhoids develop in the superior hemorrhoidal plexus of veins, which is situated in the submucosa of the true rectum and of the columnar zone of the anal portion. (Fig. 40.) There is an abundant anastomosis between the superior and the inferior venous plexuses, and

FIG. 40.



Internal hemorrhoids. Preparation injected to show the dilated veins and the branches of the superior hemorrhoidal artery. (Quénu and Hartmann.)

also between them and the middle hemorrhoidal veins, the veins about the prostate, the seminal vesicles, and the vagina. The chief site of internal hemorrhoids is the region in which the superior and inferior hemorrhoidal veins come together—that is to say, at about the level of the valves of Morgagni, 1.5 cm. (0.6 inch) above the anocutaneous line. Even under normal circumstances the little veins show enlargements in this situation, which are called venous glomeruli. These structures are made up of several small veins, which are twisted together into a round or oblong mass. In addition to the glomeruli, little dilatations can always be found in the individual veins.

Pathological Anatomy.—Microscopical examination of injected preparations of hemorrhoids shows that the arteries are never affected, while the veins are dilated in various ways. The dilatations may be round, or spindle-shaped, or of irregular form; or the veins themselves may be twisted and wound in different directions. A hemorrhoid is made up of a mass of such varicose veins, surrounded by a capsule of connective tissue which sends fibrous bands containing arteries into the centre of the nodule. In an internal hemorrhoid the veins are smaller and more twisted than those in an external hemorrhoid. In the latter the veins may measure 7 or 8 mm. (0.3 inch) in diameter, and appear more like varicose veins of the skin. The mucous membrane covering hemorrhoids is always in a condition of chronic catarrh. Sometimes the walls of the veins are thickened by inflammation, but often they are extremely thin, so that on microscopical examination nothing but the endothelial layer is seen. Such dilated and thin vessels may easily form large irregular venous cavities. Quénu, who has spent much time in the investigation of this subject, looks upon this process as a simple varicosity of the veins. Reinbach considers the essential part of the process to be a new formation of capillary vessels. Therefore he speaks of hemorrhoids as angiomata, and refers their origin to a congenital period. These results have been confirmed by Gunkel, who found, however, that the veins were varicose in a few cases of pregnancy and pelvic tumor.

The development of hemorrhoids has been supposed to depend upon increased blood-pressure. This may be due to various causes, of which the most important is a frequently repeated increased abdominal pressure which obstructs the back flow of blood and causes the veins to swell. The effect of this pressure can easily be demonstrated upon a patient with hemorrhoids if he is asked to hold his breath and strain while lying in the lithotomy position. The external hemorrhoids will dilate to several times their former diameter, and the walls of the veins will be tightly stretched. Such increased blood-pressure is a common result of chronic constipation, and this difficulty has been considered the chief cause of hemorrhoids. Persons of sedentary habit are affected more frequently than those who lead an active life. In women the flabby condition of the abdominal wall due to repeated pregnancies favors chronic constipation. In other patients increased abdominal pressure is due to stricture of the rectum or of the urethra, or to stone in the bladder, or to hypertrophy of the prostate, etc. The presence in the rectum of large hard masses of feces is of itself productive of venous obstruction.

It has also been suggested that venous obstruction may be favored by the position of the rectum at the bottom of the abdominal cavity; by the fact that hemorrhoidal veins are poorly supplied with valves; and by the further fact that the veins are somewhat constricted at the point where they pass from the submucosa through the muscular coat of the rectum. This last point is equally true, however, of the veins

of the rest of the intestinal tract. Whatever weight may be given to the different theories advanced, the fact remains that people who are obliged to stand or sit much of the time are frequently prone to develop hemorrhoids.

Tumors in the pelvis may obstruct the venous return, and thus favor the development of hemorrhoids; as examples, may be mentioned the pregnant uterus, myomata, large pelvic exudates, adhesions, and even a retroverted uterus.

It has been claimed that diseases which cause venous stenosis favor the development of hemorrhoids; but this is not the case. For example, in cirrhosis of the liver, in which the portal obstruction is at its maximum, hemorrhoids are not especially frequent. On the other hand, an active congestion may be of moment in the development of hemorrhoids by setting up inflammatory changes in the walls of the veins. Such congestion may be caused by stimulating articles of food and drink, excessive smoking, sitting on soft cushions, the use of strong cathartics, irritation by the clothing, lack of cleanliness, and sexual excesses. When the venous walls have been injured by periphlebitis and thrombophlebitis, they become less resistant, and more likely to dilate when the blood-pressure is increased. Such a primary etiology is admitted both by those who believe that hemorrhoids are due to increased pressure in the veins, and by those who believe they are true new growths—that is to say, cavernous angiomata.

Hemorrhoids are very common. Few persons pass middle life without suffering from them at least in a slight degree. Men are more subject to them than women, in the proportion of 5 to 3.

Symptoms.—External hemorrhoids appear upon examination as bluish masses as large as a pea or as large as a filbert, situated under the anal skin. Sometimes a single one is present, sometimes there is almost a complete circle of them. Such hemorrhoids are sessile, rarely pedicled. Straining increases their size; pressure of the finger makes them almost entirely disappear. The overlying skin is either thin as a result of pressure, or thickened by chronic inflammation. Such hemorrhoids, if they are not inflamed, produce no symptoms, or they may cause itching, and occasional burning. They rarely bleed. If inflammation develops in the form of periphlebitis or thrombophlebitis, the pain may be intense, the nodules becoming extremely tender and swollen and giving a sensation of throbbing in the anus, possibly associated with severe tenesmus. An inflamed hemorrhoid upon examination is found extremely sensitive, tense, and hard. It cannot be emptied by pressure since the blood in its veins is coagulated. An attack of this sort usually passes over in six or eight days. After the attack the thrombus is resorbed, but the distended skin remains as a flabby sac. In rare instances the thrombus becomes infiltrated with lime salts and remains as a phlebolith. The distended skin over the thrombus may ulcerate and allow the escape of a part of the clotted blood, thus relieving the pressure and hastening recovery. A less favorable outcome

is suppuration, followed by ulceration or a fistula. Such an ulcer, if small, may give the characteristic symptoms of a fissure. There may also be attacks of inflammation of the external hemorrhoid without the formation of a thrombus, and which pass over in a day or two.

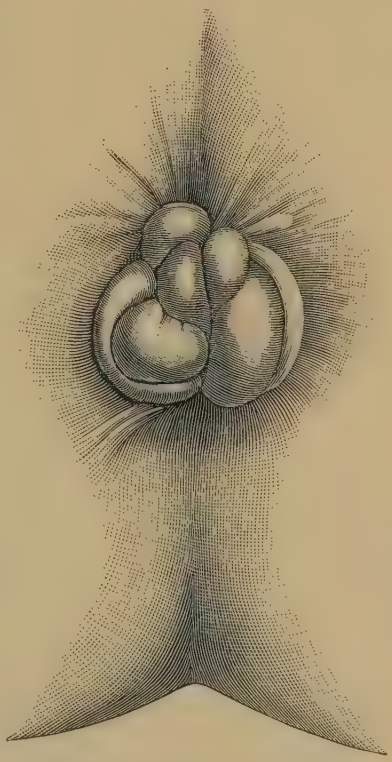
Internal hemorrhoids are usually situated at the level of or a little above the sinuses of Morgagni, where they form sessile, rarely pedicled tumors, which may be either single or multiple, so as to form a complete ring, or even more than one ring, one above the other. Each hemorrhoid may be as small as a pea or as large as a walnut. They are soft in consistence, and are usually covered by a bluish or bright-red mucous membrane which shows the effects of inflammation. They are usually movable with the mucous membrane upon the muscular plane of the bowel. If the hemorrhoids are of great size, the examining finger frequently detects in them the pulsation of the submucous arteries.

Internal hemorrhoids usually have a latent period in which the symptoms are: indefinite pain, a feeling of weight in the rectum, discomfort in sitting, with great pain at stool. Usually bleeding at stool is the first definite symptom of the trouble. The blood may be smeared upon the fecal matter, or it may flow from the anus after defecation. In the latter case it is more apt to attract the attention of the patient. The quantity of blood so lost is usually two or three teaspoonfuls. Such a hemorrhage may, however, be so great as to threaten life. The hemorrhage may be repeated at every defecation, or it may not occur again for months. Sometimes the patient will feel much relieved after hemorrhage. At other times the repeated loss even of small quantities of blood produces a well-marked anæmia. The source of the blood is usually from dilated capillaries in the mucous membrane which have been opened by a slight erosion. The blood may, however, come from a ruptured varicose vein. When one remembers how readily the rubbing of an internal hemorrhoid with a piece of gauze starts bleeding, it is easily understood that the passage of fecal matter will often produce the same result. Straining at stool may cause the blood to spurt out. From this fact, and from the further fact that its color may be bright red, it is not safe to conclude that it comes from an artery. The spurt may be due to the straining of the patient, and the color either to its capillary origin or to its exposure to air.

A second important symptom of internal hemorrhoids is the ease with which they become prolapsed, due to the freedom of movement of the mucous membrane upon the deeper structures. (Fig. 41.) Pressure at stool and the outward movement of hard fecal masses tend to drag the mucous membrane downward, and finally to bring it out through the sphincter. At first the hemorrhoids slip back as soon as the pressure is relieved. Later, when the elasticity of the tissue has diminished, they have to be replaced digitally, or possibly they remain outside of the sphincter and cause a great deal of trouble. Prolapse may also be produced by coughing, sneezing, or even by walking. Reduction of prolapsed hemorrhoids is easily performed unless they are strangulated on

account of the tight contraction of the sphincter, or have become inflamed. Under such circumstances the prolapsed hemorrhoids appear as a circle of bluish-red, shining, tender masses of mucous membrane, varying in size up to that of a filbert, or larger, lying outside of the anus. They are usually surrounded by a ring of external hemorrhoids covered by inflamed skin. The more swelling there is, the more difficult the replacement will be. Under such circumstances pain may be intense, with marked tenesmus, etc., frequently with retention of urine and fever, or vomiting and abdominal distention, with the other symptoms of ileus. Spasm of the sphincter muscle constantly increases the swelling. The prolopsed hemorrhoids become hard and blue, and may in a few days become entirely gangrenous and finally be cast off. The ulcers which follow may gradually cicatrize, and the process terminate as it were in a natural cure. Abscesses and fistulas, or even pyæmia or suppurating thrombi, are less happy sequels; while dangerous hemorrhage is a rare symptom.

Fig. 41.



Prolapsed hemorrhoids. (Quénu and Harrimann.)

The third important symptom of internal hemorrhoids is the rectal catarrh, which shows itself by an increased secretion of mucus, either at stool, or, in the more severe cases, at other times as well. The mucus may be so abundant that it saturates the clothing and keeps the skin about the anus in an inflamed condition. Such instances are almost entirely confined to old individuals, in whom the sphincter is weakened so that there is a constant prolapse. The symptoms of this chronic catarrh may be varied by those of acute attacks of obstruction, strangulation, thrombophlebitis, etc. Chronic rectal catarrh may develop after the hemorrhoids have formed, or it may precede them, and thus become by means of the inflammation and obstruction a favoring factor. Internal hemorrhoids, like the external, are subject to attacks of acute inflammation, thrombophlebitis, and periphlebitis, which, without the occurrence of strangulation, may cause hard swellings and possibly terminate in suppuration. Talka found fissures, ulcers, erosions, or fistulas in 45 per cent. of his patients with hemorrhoids.

Examination of Patient.—The patient should be placed either on the side or in the lithotomy position, and asked to strain hard. This causes the external hemorrhoids to swell. If the examination has been preceded by a warm sitz bath, the swelling will be more marked. Internal hemorrhoids will not be visible unless they prolapse easily. They can be well exposed under general or local anæsthesia by dilating the sphincter and introducing a speculum. Digital examination should not be neglected, since some other abnormality—for example, carcinoma—may exist with internal hemorrhoids.

Prognosis.—The patient with hemorrhoids usually suffers little as long as there is no complication. Many patients go on thus for years without learning what distressing symptoms may be caused by their trouble. The complications above spoken of—hemorrhage, prolapse, catarrh, ulceration, formation of fistulas, fissures, etc.—do not take place in the majority of instances.

Treatment.—In the treatment of hemorrhoids it is important to ascertain when possible the cause of the trouble in order to remove it. Chronic constipation should be treated according to the principles given in medical text-books, by a correct diet, suitable exercises, massage, etc. Even then cathartics cannot be entirely dispensed with. The least objectionable are injections of glycerin, or oil, or cool water. Of the medicinal remedies, rhubarb, tamarinds, cascara, and salines do the least harm. It is especially important to prevent fecal masses from remaining for a long time in the rectum. A patient troubled with hemorrhoids should carefully wash with soap and water after each defecation.

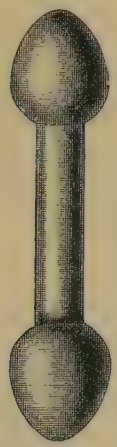
The immediate treatment of hemorrhoids may be palliative or radical. The dumb-bell pessary is an illustration of the former: it consists of a short, hard rubber rod, terminating at either end in an olive-shaped ball. (Fig. 42.) The rod is just long enough to allow the upper ball to rest above the sphincter in the rectum, while the lower one lies below the sphincter in the anus. This pessary is worn at first for an hour or so daily, and later almost all the time. It does not irritate the mucous membrane and appears by continuous pressure to cause the hemorrhoids to atrophy. Cold douches are another valuable palliative. A stream of water should be thrown against the anus one or twice a day for a minute at a time.

Absolute cleanliness is an essential in the treatment of external hemorrhoids. This is obtained by washing or by sitz baths. A bit of cotton soaked in oil may be kept between the buttocks to prevent chafing. Erythema and eczema should be overcome by the application of zinc or lead salve, by a wet dressing, or by pencilling the affected skin with a 1 to 3 per cent. solution of silver nitrate. If the patient complains of pain, it will usually be found upon examination that the hemorrhoids are inflamed. Under such circumstances he may remain in bed with the pelvis raised, or lying upon the stomach. Ice, leeches, suppositories containing opium, cocaine, or morphine, or subcutaneous injections of morphine may be necessary to control the pain. An

attack of this character will pass over in a week or less. Such patients are apt to avoid defecation on account of the pain which it causes. This is an unfortunate delay, since the mass of feces grows larger and harder and is with great difficulty evacuated. The best plan is to give the patient castor oil or salts daily, and to soften the fecal matter by means of injections.

If the inflammation increases in intensity, suppuration is apt to follow thrombosis. Under such circumstances the best plan is to make an early incision and evacuate the blood-clots as well as the pus. The pains will rapidly subside and the small wounds heal without difficulty. The surgeon may seize the opportunity to touch other uninflamed hemorrhoids with the Paquelin cautery in order to cause them to atrophy. If the external hemorrhoids are complicated by fissures, proper treatment for them should be administered.

FIG. 42.



Dumb-bell pessary.

FIG. 43.

Supporters for hemorrhoids.

Internal hemorrhoids in many instances require only palliative treatment. If the hemorrhage is of small amount and rarely occurs, it may be neglected altogether, or the mucous membrane may be swabbed with some astringent. Profuse hemorrhage calls for radical treatment. The first thing is to put the patient in a horizontal position or to elevate the pelvis in order to control the hemorrhage; but it should not be forgotten that the blood may collect in the rectum or pass into the colon. Rapidly progressive anæmia or a desire of the patient to evacuate the bowels suggests such a condition. Well-known remedies are ice or ice water in the rectum, or very hot water (39° to 45° C.; 102° to 113° F.), or a solution of tannin (2 per cent.), or of lead acetate (3 per cent.), or of alum (2 per cent.), or suppositories of ferric sulphate: but their efficacy in checking the hemorrhage is doubtful. It is rather to be recommended in urgent cases to fill the rectum with

iodoform gauze through a speculum, the patient being given a local or general anæsthetic. A still more satisfactory method of cure is to expose the bleeding point and apply a ligature, or remove the hemorrhoid by a cautery.

Prolapse of the hemorrhoids may be treated palliatively. They should in any case be replaced, since the constriction of the sphincter will cause swelling and ultimate gangrene. For this purpose the patient should lie upon the back or side, or rest upon the elbows and knees. The prolapsed hemorrhoids should be painted with a 5 per cent. solution of cocaine, well oiled, and replaced one at a time by steady pressure of the finger or a cotton swab. The condition may be so painful as to require infiltration anæsthesia, or even general anæsthesia. The after-pains are best treated by rest and horizontal position. A dumb-bell pessary will prevent the hemorrhoids from coming down between stools, or supporters of other shapes may be employed. (Fig. 43.) If a prolapsed hemorrhoid is already gangrenous, it should not be replaced. Treatment should then be directed to the relief of pain until the gangrenous part is cast off.

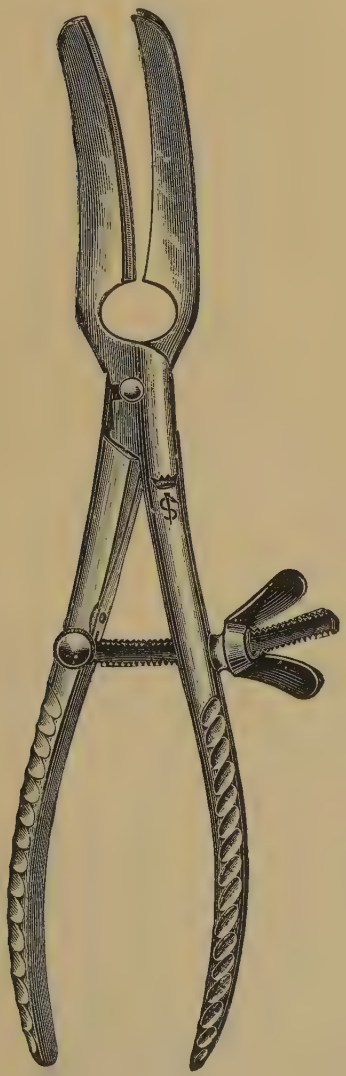
In many cases palliative measures fail to relieve the symptoms. Indications for radical treatment are as follows: oft-recurring hemorrhage of considerable amount; frequency of prolapse, or a difficulty of reposition after prolapse; repeated inflammatory attacks, making defecation very painful.

A patient who is to be operated upon for hemorrhoids should take castor oil for two days in order thoroughly to empty the bowels. He is then placed under a local or general anæsthetic and put in the lithotomy position, while the parts are thoroughly cleaned. The sphincter is gradually dilated until the hemorrhoids are exposed. The individual nodules are seized with a special forceps (Figs. 44 and 45) so applied that the pinch of the mucous membrane shall extend longitudinally and not transversely. As a further precaution against stenosis there should be considerable mucous membrane left between the portions to be excised. A second clamp is applied to the pedicle of the hemorrhoid and the hemorrhoid is divided between these two clamps by means of the point of the cautery. If the hemorrhoid is a large one, it may be cut off with the scissors in order to save time, and its stem cauterized. If the cautery is not too hot, and is thoroughly applied, there will be no bleeding upon the removal of the second clamp. If an artery spurts, it should be ligated. Dilated veins that are not large enough to be removed in this manner may be punctured with the point of the cautery. When all the hemorrhoids have been treated in one of these ways, a thin tube wrapped with iodoform gauze is passed through the sphincter to allow the escape of gas; the anus is smeared with vaselin and a dressing of gauze and cotton applied and held in position by a T-bandage.

Some patients have no pain after such an operation, while others suffer so much as to require morphine injections. It is unnecessary to

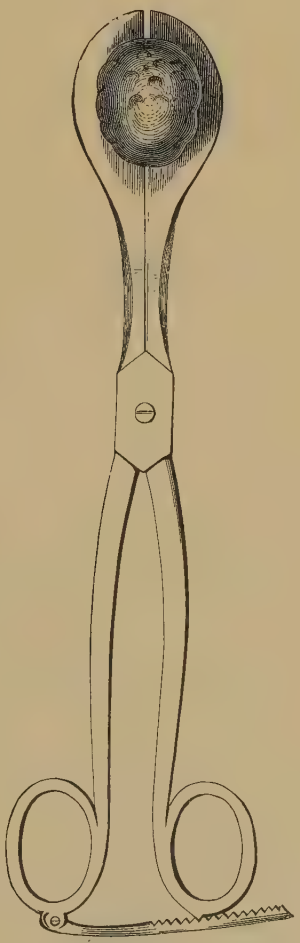
give opium in order to delay defecation. Retention of urine is a common symptom which will require catheterization. On the third or fourth day castor oil and an enema should be given in order to facilitate defecation, but even then the process is usually painful. Some surgeons

Fig. 44.



Kelsey's pile-clamp.

Fig. 45.



Langenbeck's pile-clamp.

prefer to give a laxative on the day after operation. Defecation is then less painful, but may be followed by some rise of temperature. Either during defecation or immediately afterward the patient should

sit in a warm bath for the sake of his comfort and cleanliness. After the fourth day the bowels should act daily. The patient may get up in a week, though a perfect cure requires from three to six weeks. If the operation has been properly carried out, there is no necessity to pass rectal bougies in order to prevent cicatricial contraction. For the purpose of cutting off the hemorrhoid one may use the tip of the galvanocautery instead of the thermocautery.

The mortality of the operation for hemorrhoids is very slight (Smith, 1 patient in 400; Rotter, 0 in 200).

Removal of hemorrhoids by means of the knife or scissors was practised in the preantiseptic days, but was apt to be followed by serious infection. In recent years it has been strongly advocated by Whitehead, Esmarch, Sendler, Mikulicz, and others. Whitehead operates with all aseptic precaution with the patient in the lithotomy position. He prevents soiling of the parts with fecal matter by stuffing iodoform gauze high up into the rectum. Mikulicz allows cold boric acid solution to flow over the field of operation. The sphincter is first dilated and a circular incision is begun posteriorly in the border-line between the skin and mucous membrane. The external hemorrhoids are dissected free from the overlying skin and separated from the submucous connective tissue, all vessels being ligated. Internal hemorrhoids of the posterior rectal wall are treated in the same manner. The mucous membrane of the rectum is divided transversely above them and brought down and stitched with silk to the external skin. The hemorrhoids of the right and left sides are next treated in the same manner and the wounds closed with stitches. It is necessary to carry out this dissection a little at a time, otherwise the hemorrhage is controlled with difficulty, and the mucous membrane if cut all the way around before stitched at any point draws away up into the rectum. When the sutures are all in place, a tube wrapped with iodoform gauze is inserted and the usual dry dressing applied. Mikulicz does not employ a tube. After this operation there should be no movement of the bowel for eight or ten days in order that the wound-surfaces may not become infected.

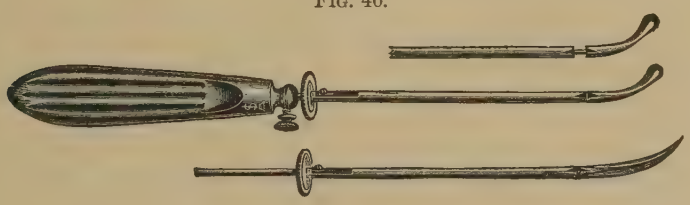
If the hemorrhoids extend high up in the rectum, the stitching of the cut edge of the mucous membrane to the skin produces considerable tension. As a result of this the stitches may pull out and allow the mucous membrane to retract upward. If the circular wound which thus results heals by granulation, stenosis is likely to follow. Such a result is not common, but must be borne in mind. In order to avoid this possibility Quénu removes the submucosa with the attached hemorrhoids, leaving the mucosa in place. Naturally then tension will be avoided. In order to accomplish the same end, Reclus leaves a strip of mucosa anteriorly and posteriorly. The conditions are naturally more favorable if only individual vessels are distended into hemorrhoids instead of a complete ring being present.

In comparing the two methods of cauterization and excision one

must admit that the results after excision, when the wound heals by primary union, are superior to those after cauterization; the period of recovery is less and the pain less. On the other hand, excision is a longer operation, more difficult to carry out, and is more likely to be accompanied with severe hemorrhage. The risk of infection is also greater in excision than in cauterization. The risk of stenosis after excision, while slight, is not to be forgotten. Stenosis has followed cauterization, but will not do so if the cauterization is properly performed. Excision cannot safely be performed if the hemorrhoids are inflamed; cauterization can be carried out successfully even if the hemorrhoids are inflamed. It is performed by most German surgeons not only for individual hemorrhoids, but also for complete prolapsed ring of hemorrhoids. Still, there are some surgeons who have performed a great number of excisions without accident (130 cases in Mikulicz's clinic with a mortality of 1.5 per cent.).

Hemorrhoids may be treated by means of a ligature. This method of treatment is especially adapted to internal hemorrhoids. The hemorrhoid is grasped with a clamp and drawn outward, while a firm elastic ligature is fastened around its base. In from five to fifteen days the gangrenous hemorrhoid falls off with this ligature. Another method is to grasp the hemorrhoid with the forceps and with the scissors to cut its base from below upward until only mucous membrane and vessels remain; a silk thread is tied around this remnant of the pedicle. (See Fig. 46.) The hemorrhoid and pedicle will fall off in six or seven

Fig. 46.



Allingham's ligature-carrier.

days; the resulting ulcer will heal in two weeks. It is simpler after the ligature has been firmly tied to cut off or burn off the surplus tissue. Allingham has treated 1600 patients by this method without a fatality. It is claimed that suppurating thrombophlebitis and pyæmia may follow this operation.

Simple dilatation of the sphincter has a good effect upon hemorrhoids. It relieves the symptoms due to prolapse, but it cannot effect a radical cure. The assumption upon which it was based, that the venous stenosis was due to contraction of the sphincter, is a false one. Any attempt to cure a hemorrhoid by burning its surface with caustics is likely to fail because the cauterization does not penetrate deep enough.

Kelsey treats hemorrhoids by injecting into each hemorrhoid after

cocainization a mixture of carbolic acid and glycerin in the proportion of 1 to 5. When the point of the needle reaches the centre of the hemorrhoid, from 1 to 5 drops are injected. The needle is left in the hemorrhoid for a few minutes until coagulation takes place, so that when it is withdrawn the carbolic acid will not flow out. As an additional precaution against burning the skin, the mucous membrane should be smeared with vaselin before the injection is made. Such an injection produces slight pain, and the hemorrhoid swells and becomes harder. The swelling subsides after some days, and the thrombus is absorbed and the hemorrhoidal nodule disappears. The patient is then able to resume his occupation. This treatment sometimes produces gangrene or suppuration, and is frequently followed by recurrence of the trouble.

PROLAPSE OF THE ANUS AND RECTUM.

Pathological Anatomy.—The simplest cause of prolapse of the anus is thickening of the mucous membrane due to inflammation or other conditions—for example, hemorrhoids. If there is not sufficient space for the mucous membrane in the anal canal, it naturally pushes outward. In other instances the prolapse is due to loosening of the innermost lining of the rectum from its deeper muscles. It is naturally held in place by the submucosa, and if this is unduly stretched by inflammation, the passage of hard feces, etc., the motility of the anal mucous membrane is abnormally increased, so that it is forced out of the anus with every increase of the abdominal pressure. If the power of the sphincter muscle is also weakened, the tendency to prolapse is increased.

If the anal mucous membrane protrudes from the anus, the condition is spoken of as prolapsus ani; if the rectum, not merely its mucous membrane, but the whole rectum, is loosened from its attachments to the levator muscle, prostate gland, or vagina and coccyx, so that it protrudes through the sphincter, the condition is known as prolapsus recti. If the prolapse is present in an extreme degree, the portion of the rectum which is partly covered with peritoneum may pass out through the anus, producing a rectal hernia. In Douglas's pouch, which then lies to the front of the prolapse, there may be found sigmoid flexure, small intestine, ovaries, bladder, etc.

According to Esmarch's view, prolapse of the anus precedes in development that of the rectum. Waldeyer and Ludloff, while admitting that prolapse of the anus takes place in the manner described, claim that prolapse of the rectum is never caused by dragging from below, but by pressure from above. Intra-abdominal pressure being directed against Douglas's vault, especially in persons with constipation, depresses this vault little by little. Since its posterior wall is closely associated with the anterior wall of the rectum, the rectum may be pushed through the sphincter downward, especially if the wasting of fat has loosened its attachments. In this manner it may be gradually

forced out through the anal canal. Naturally the posterior wall of the rectum follows the anterior wall, and even the sigmoid flexure may be pushed downward in this manner. If the process is complete and the interior of Douglas's pouch extends beyond the anus to form a part of the anterior lip of the prolapse, the condition is called by Waldeyer a median perineal hernia. If Douglas's pouch does not reach the outward world through the anus, he speaks of it as an incomplete hernia, the degree of which is gauged by the depth to which Douglas's pouch is distended. It is claiming too much, however, to assign this cause to all cases of prolapsed rectum, as instances are numerous in which prolapse of the rectum is clearly secondary to prolapse of the anus, and in which the prolapse of the rectum is due to a loosening and stretching of its normal attachments, rather than to a deepening of Douglas's pouch. These attachments are fibrous bands between the rectum and the parietal fascia of the pelvis which are situated laterally in the perirectal fatty tissue. Branches of the middle hemorrhoidal arteries are closely associated with them. Other attachments are found in the arteries and fibrous bands of the mesorectum and in the peritoneal covering which is firmly bound down to the promontory.

If the rectum alone is prolapsed, the condition is one of invagination, and a finger introduced into the lumen of the invaginated portion can distinctly feel the portion which has retained its normal situation. If both the rectum and the anus have prolapsed, no such distinction can be made out.

It should also be mentioned that higher parts of the intestinal tract may be found in the rectum or prolapsed through the anus; thus the colon may be invaginated as a result of polypoid tumors or carcinoma, or stricture of the rectum. Under such circumstances the fold where the invaginated portion turns into the portion which remains in a normal position cannot be reached by the finger.

Etiology.—The conditions which bring about prolapse are commonest in childhood. A long-standing diarrhœa may influence the mucous membrane, swell the submucous and perirectal connective tissue, and relax the sphincter muscle. Even without such inflammatory process the connective tissue in a young child is very soft, and its muscular system is less developed than in later life. In a child, too, the curve of the sacrum is less marked than in an adult, so that the closure of the pelvic cavity is almost entirely a muscular one. If therefore a child is in the habit of straining very hard at stool on account of diarrhœa with tenesmus; or if he strains on account of worms, or phimosis, or stone in the bladder; or suffers from whooping-cough; or if the mesosigmoid is of unusual length; or if there are polypi of the rectum, or a congenital stenosis is present, rectal prolapse may easily result.

In later life prolapse of the rectum is less often seen, and then usually in women whose perineum has been much damaged by repeated labors. As a rule either the vagina or rectum may prolapse. Fre-

quently a prolapse of both organs coexists. The next important cause in adults, both for man and woman, is internal hemorrhoids with constipation. Stone in the bladder, stricture, or insufficient sphincteric action, is less apt to cause prolapse in later life than in childhood. Rectal polyps and stricture may lead to invagination. In advanced life prolapse is relatively more common on account of the loss of tone of the muscular and other tissues.

Symptoms.— The first thing noticed by the patient is the protrusion at stool of a small part of the anal mucous membrane, usually at one side. The amount of mucous membrane which protrudes increases until complete prolapsus ani exists, which may be followed by prolapsus recti. This order may be reversed, as has been already stated. In the beginning of the trouble the mucous membrane which is prolapsed by defecation slips back of itself or is easily replaced. If the sphincter acts very strongly, it may obstruct the venous flow in the prolapsed portion and cause swelling and transudation, and make reposition difficult. It is rare that gangrene is due to this cause. In long-standing prolapse the anal mucous membrane either remains constantly protruded or comes out through the anus very soon after replacement, especially when the patient is in an upright position.

The size of the prolapse depends naturally upon the amount of the rectum involved. When the prolapse is complete, the mass may be 10 cm. (4 inches) long, or longer, and of considerable thickness, since it is composed not only of mucous membrane, but of the whole rectal wall. The lumen of the bowel will be found at the lowest point. Pressure of the sphincter and mechanical irritation may produce catarrh, hemorrhage, or ulceration of the prolapsed mucous membrane. In rare instances the sphincter muscle may strangulate the whole prolapsed portion of the bowel and give rise to the symptoms of ileus and gangrene, with fatal peritonitis. The gangrenous portion has been known to slough off, and thus terminate the process in a rude, natural cure. The mucous membrane which remains permanently outside the anus becomes dry and leathery and much less sensitive than usual, and except from possible ulcerations there is very little secretion from its surface. In severe cases incontinence of feces is apt to be present, due partly to weakening of the sphincter muscle, and partly to lack of sensitiveness of the rectal mucous membrane, the patient being unaware that fecal matter is approaching the anus.

In these cases of large prolapse it is well to remember the possible presence of intestinal contents in a hernial sac placed anteriorly. Intestinal gurgling will usually be heard during attempts at replacement. The presence of the intestine in such a sac usually changes the shape of the prolapse from a cylindrical to a somewhat more spherical one. The lumen of the bowel is pushed farther back. If, by reason of inflammation, the layers of the peritoneal pouch adhere, it will no longer be possible to replace the prolapse. Such adhesions may take place when the sac is empty, or one or more loops of intestine may be

adherent in the sac. The risk of strangulation at the sphincter with fatal gangrene and peritonitis will then be increased.

Treatment.—Prolapse in children if of recent occurrence, can almost always be cured by relieving the cause, which is usually diarrhœa. If the child is rhachitic, the proper medicines should be prescribed, such as phosphorus and codliver oil. If there is no diarrhœa, an attempt should be made to learn the cause of the prolapse in order to relieve it.

There are certain palliative measures which render protrusion of the bowel difficult or impossible. The child ought not to sit and strain too long at stool; indeed, it is better that it should remain in bed for a time and defecate in a bed-pan. Later, when up and about, the nates should be strapped together with strips of adhesive plaster placed transversely in such a manner that the feces may pass out between them. With care the child can be properly cleansed while the plaster is in place. If prolapse occurs, it is essential that it should be replaced at once so that the mucous membrane shall not be injured. For this purpose the child should lie on the back with the hips raised, or upon the stomach. If the bowel is strangulated, or the sphincter so tight that it must be stretched to permit reposition, an anæsthetic should be given. If the prolapse is very large, one ought to replace first those parts which have come out last. No haste or violence is permissible. It is usually impossible to do anything while the child is crying. Gentle and continuous pressure with the fingers upon a soft oiled napkin is the best method of reposition. If it is impossible to replace the prolapse by this gentle means, one of the radical procedures mentioned later must be chosen. In children if the bowel does not reappear for some weeks the cure may be regarded as permanent.

If the prolapse has been neglected so that the thickened mucous membrane is swollen, astringents should be applied to it, and attempts made to increase the tone of the weakened muscles. For this purpose subcutaneous injections of strychnine or ergot, and massage according to the directions of Thure-Brandt, or Zander, should be tried. Langenbeck used the following solution—extr. secal. cornut., 2.5; spirit. dilut., glycer., āā 7.5—of which he introduced from half a syringe to a syringefull in the perirectal connective tissue. From one to five injections will often bring about a cure. Some such plan should be followed before operation is decided upon. Apparatus to prevent the bowel from prolapsing irritates and often fails of its purpose, and is therefore not to be recommended. If these milder measures are unsuccessful, radical methods of treatment may be adopted.

Cauterization and excision of the mucous membrane is a method of treatment especially adapted to prolapsus ani, a condition in which only the mucous membrane is affected. Cauterization is performed in a manner similar to cauterization for hemorrhoids, the only difference being that the clamps should seize a fold of mucous membrane whose length corresponds to the size of the prolapse. If the cauterization is followed by bleeding, the edges of the burnt wound should be stitched together by

a continuous catgut suture. Not more than four folds of the mucous membrane should be treated in this manner, the operator being sure that between the eschars there is a broad strip of uninjured mucous membrane to prevent cicatricial contraction and stricture. In suitable cases the results of this method of treatment are excellent. If the sphincter is very much weakened and dilated, the anus must be narrowed by operation.

Some operators have attempted to cure by cauterization not only prolapsus ani, but also prolapsus recti, hoping to reduce the lumen of the rectum, and possibly to affix the rectum to the pelvic wall by means of inflammation secondary to the cauterization. Energetic treatment of this sort may lead to the formation of a stricture, and if so, the patient will be far more uncomfortable than he was with his prolapse. Moreover, adhesions due to inflammation and suppuration gradually become soft, and in six months or a year recurrence will be likely to follow an apparent cure of this character. Others have suggested the removal of longitudinal strips from the rectum and suture of the wounds thus caused. This treatment, like that of cauterization, is adapted to prolapsus ani, but is likely to fail in prolapsus recti. Delorme resected with success 30 to 80 cm. (12 to 32 inches) of prolapsed bowel, suturing the cut ends.

The second method of treatment intended to cure prolapse of the rectum is the narrowing of the anus to such an extent that the bowel can no longer pass through it. Many years ago this was carried out by the excision of numerous radial folds about the anus or above it, or by the cauterization of the whole anal skin in order to form a circular scar. Improvement due to these measures is likely to be temporary, or stenosis may result. A better method is that of Kehrer, who cuts from the posterior margin of the mucous membrane a triangle 6 cm. (2.4 inches) broad at the base and 3 cm. (1.2 inches) high, the point being directed upward. The exposed portion of the internal sphincter is then drawn backward with a hook, and held there by stitches passed through the anal skin and sphincter muscle. König has also succeeded by this method, but prefers to cut away the exposed portion of the external sphincter and unite the divided ends with catgut. Thiersch has reduced the calibre of the anal ring by means of a silver wire passed subcutaneously. He uses a curved needle, inserting it in the median raphe 1.5 cm. (0.6 inch) behind the anus, which it circles subcutaneously. Once or twice on its way around the needle must be passed out through the skin, but is reinserted in the same opening until it is brought out through the first puncture made in the median raphe. The silver wire will then lie subcutaneously completely around the anus. The ends are twisted together, cut off short and buried under the skin. The prolapsed rectum should be replaced either before the wire is inserted or before its ends are twisted together. The patient experiences some pain for a few days, but is not obliged to remain in bed. It is desirable that the stools should be kept in a semiliquid

condition for a week or two. Slight suppuration taking place about the wire, may subside without making necessary the removal of the wire. If the patient is cured, the wire may be left in place permanently, or removed in a year or so.

The prolapsed bowel may be resected and the cut ends united by a suture. The patient should be prepared for the operation by the administration of laxatives for several days. Two threads are passed through the crest of the prolapsed bowel for tension, and the outer bowel is then cut across anteriorly 1 or 2 cm. (0.4 to 0.8 inch) below the sphincter and the vessels ligated. This cut opens the peritoneal cavity. Any prolapsed contents abdominally or otherwise are then replaced and the peritoneal surfaces are stitched together with silk. The anterior wall of the inner bowel is then cut across, its vessels ligated, and its upper cut edges stitched to the cut edge of the lower bowel, the ends of the sutures being used as tension threads. The posterior wall of the prolapse is next divided little by little, the vessels being ligated, and the inner and outer bowel-walls being sutured as fast as the cuts are made. Retraction of the bloodvessels is thereby avoided. The peritoneal cavity does not usually extend to the posterior portion of the prolapse. It frequently happens that the circumference of the outer bowel is so much greater than that of the inner that it is impossible to adjust the two accurately. This will leave a gap posteriorly to be drained with a wick of iodoform gauze. When the suture is complete, the bowel will usually replace itself spontaneously. It is not necessary to place a tube in its lumen. A light external dressing will suffice. The most important point in the after-treatment is to keep all fecal matter away from the wound for eight or ten days. This is best accomplished by repeated evacuations for three or four days before the operation, and by a fluid diet, and opium for a week after the operation.

Resection of the prolapsed rectum as thus carried out by Mikulicz is not without danger on account of the length of time of the operation, loss of blood, and the further fact that it is often performed upon old, feeble patients. Moreover, it is difficult to disinfect the parts. Ludloff found that death followed 6 times in 47 cases, from hemorrhage, or weakness, or rupture of the suture-line with resulting peritonitis. If the patient recovers from the operation, he still runs the risk of either stricture or recurrence of the prolapse. That recurrence takes place so frequently is due to the fact that operations fail to restore the peritoneal reflection to its normal level, but only to the level of the anus. In spite of these drawbacks resection is a most valuable method of treatment.

Weinlechner resects the prolapsed rectum without any anæsthetic except the application of cocaine to the mucous membrane, in the following manner: A hard rubber tube, at the upper extremity of which is a circular gutter, is passed into the prolapsed bowel up to or a little above the anus; the bowel is then drawn down with two or three stitches, while

a strong rubber ring is passed up over it until it lies in the gutter of the hard rubber tube. The pressure of the elastic ring will cause the prolapsed bowel to slough off in eight or ten days. Before the ring is slipped in position the anterior peritoneal sac should be emptied. To prevent the ring from slipping out of position, one or two stitches may be inserted; or two long pins may be thrust through the bowel just below the ring. This operation can be performed in a few minutes, and is especially adapted to enfeebled patients, or those in whom the prolapsed bowel is greatly swollen or becoming gangrenous. This method of operation is not without danger, since 2 of 9 patients on whom it was performed died, one of weakness, and the other from peritonitis caused by the fact that the ring cut through the tissue before the peritoneal layer had become adherent. Recurrence of stricture may follow Weinlechner's method just as it may that of Mikulicz.

A fourth method of treatment of prolapse is known as rectopexy or colopexy. The principle is to replace the prolapsed bowel and to fix it in its original position by some method of suture. If the rectum itself is sutured, the operation is spoken of as rectopexy; and if the sigmoid flexure is sutured, the term colopexy is employed.

Rectopexy, first proposed by Verneuil in 1889, is performed as follows: The prolapsed bowel is replaced and a triangular flap is cut posteriorly, the apex being at the point of the coccyx, and the base 6 or 8 cm. (2.2 or 3.2 inches) broad, reaching to the margin of the anus. The skin, fat, and muscles, including the corresponding portion of the rectum, are cut through and removed, but the anal canal is not opened. The circumference of the anus and the ampulla is next reduced by the insertion of four transverse sutures, the needle passing through the muscular coat of the bowel, but not through its mucous membrane. When these sutures are drawn tight, a longitudinal fold is made in the lumen of the bowel, and its circumference is reduced by just so much. The ends of these sutures are passed upward subcutaneously to emerge through the skin, and are tied, the uppermost one at the level of the lower end of the sacrum, the others somewhat below this level. These serve therefore not only to narrow the lumen of the rectum, but also to elevate the rectum as a whole. The divided ends of the sphincter are stitched together and the cutaneous incision is sutured.

Marchand modifies slightly this method of operating by substituting a linear incision for the resection of the triangle, and suspends the bowel to the sacrum and coccyx. He narrowed the anus by a purse-string suture in place of resecting a portion of the sphincter.

König cuts a triangle so as to include the muscles, the whole thickness of the rectal wall, and the anus.

Thus far no fatal case of rectopexy has been reported. Suppuration has sometimes followed this operation, thus defeating the attempted cure. Relapse has also been reported in instances in which the wound healed primarily. Such a relapse may consist solely of mucous membrane, in which case it may be treated successfully by cauterization.

The difficulties of this method, aside from the risk of infection, rest in the fact that too short incision allows a fixation of only a small part of the posterior wall of the rectum, and the further fact that the sutures are liable to cut their way through the flabby tissue. The good results reported are doubtless largely due to the narrowing of the anus. As soon as the cicatrix in the sphincters begins to stretch recurrence is apt to take place. König therefore advised that the operation should be performed only in case the prolapse is easily reducible and complicated with paralysis of the sphincter of extreme degree. It is also a suitable operation for commencing recurrence after other operations.

Colopexy, or ventral fixation of the sigmoid flexure, as a cure of prolapsus of the rectum, was proposed by Jeannel in 1889. It is based on the theory that the rectal prolapse is due to stretching of the mesorectum and the mesosigmoid. He performs the operation as follows: Through a short incision in the left hypogastrium, the sigmoid flexure and rectum are drawn upward until the prolapse is completely replaced. The corresponding part of the bowel is then stitched in the wound by means of a serosa-muscular suture. To make the fixation more firm, the mesosigmoid may also be stitched in the wound to the parietal peritoneum. If the uterus is also prolapsed, it may be fixed in the lower angle of the same wound. The abdominal wound is then closed. Eiselsberg has performed this operation 12 times without mortality.

An examination of the records of 33 cases of colopexy shows that a cure was effected 26 times, while in 7 cases there was a partial or a total recurrence. The period of observation was not long enough in most cases to show the permanency of the cure.

Choice of Operation.—The best treatment for prolapsus ani is cauterization of the superfluous membrane. If the prolapsus of the rectum or of the rectum and anus is complicated with ulcer, or is irreducible, the best method of treatment is resection according to Mikulicz. If the prolapsus is irreducible or gangrenous, or the lack of assistants or the condition of the patient makes it desirable to proceed as quickly as possible and without loss of blood, Weinlechner's method of strangulation may be chosen. In uncomplicated prolapse Thiersch's silver wire method should be tried. It has been claimed that the replaced rectum will lie in so many folds that it will seriously interfere with defecation; but experience has not proved such to be the case. Another objection to this method is the fact that it does not elevate the deep situation of Douglas's fold; but neither resection nor rectopexy, or colopexy, will do this. Moreover, the silver wire method permanently narrows the anus, whereas excision of a triangle leaves a scar which may give way and thus defeat the cure. If, on account of a failure in technic the ring cuts through the skin and has to be removed, it may be again inserted at a subsequent date.

A very large prolapse may be treated by resection or colopexy. The latter operation is simpler, entails less risk, and produces about as good results as the former.

In spite of all methods of operation there are some difficult, complicated cases in which prolapse of the rectum is associated with prolapse of the vagina and the uterus, of the stomach, etc., in which the surgeon is unable to effect a cure. There are other cases in which adhesions in a large hernial sac prevent replacement of the prolapsed bowel even after the sphincter has been dilated. Under such circumstances it may be necessary to open the hernial sac to free the adherent intestine, and by division of the sphincter muscle to accomplish replacement of the prolapsus. If the incarcerated intestine is gangrenous, it should be treated in accordance with the principles laid down in the chapter on Strangulated Hernia.

TUMORS OF THE ANUS AND RECTUM.

Benign Tumors of the Anus.

Benign tumors of the anus are rare. Pointed condylomata occur, due either to mechanical irritation or to irritation from gonorrhœal discharge. They are found almost exclusively in women, and are due to the flow of the discharge backward from the vagina. These condylomata usually develop in small groups, but they may be present in such great numbers that they form a mass about the anus as large as the closed fist. They have been mistaken for carcinoma. Inspection will show, however, that the skin is not infiltrated, and that the base of the condylomata is soft. Histologically they present the appearance of papillomata. A papillary body grows from the connective tissues of the skin, contains bloodvessels, and may be divided into branches. Its surface is covered with a thin layer of epidermis, which may be rubbed off in places so that the surface is wet with serum and possibly blood.

Treatment.—The treatment of pointed condylomata consists in snipping them off with scissors and cauterizing the bleeding parts with silver nitrate. If the mass is very large, a general anæsthetic is advisable. The affected parts should be kept dry by powdered bismuth, orthoform, etc., and a fold of gauze should be kept between the nates until recovery is complete.

In this region are also found atheromata, and occasionally cysts, which have developed from hemorrhoidal hæmatomata, and little fibromata, which may or may not be pedicled.

Malignant Tumors of the Anus.

Cancer of the rectum, according to Funke and Kraske, does not start at the anus in more than 3 or 4 per cent. of the cases. When it does begin there, it finds its origin in a fissure or fistula, or a hemorrhoidal nodule which has been subjected to irritation. The growth begins at the margin of the anus, either in the skin or mucous mem-

brane, and exhibits either a tendency to spread laterally or else to extend into the deeper tissues, according as it has developed from the superficial epithelium or from that of the sebaceous or sweat-glands. The superficial carcinoma is marked by a shallow ulcer with hard, infiltrated border, the result of degeneration in the centre of the carcinomatous nodule. Carcinoma which attacks the deeper tissues appears first hard and nodular, and as degenerative processes affect it a deep ulcer may be formed, so that the sphincter muscle may be destroyed. The edges of the ulcer may show warty outgrowths so that the whole cancer has a cauliflower appearance. Among the rarer instances may be mentioned a soft medullary and a melanotic carcinoma of the anus.

As contrasted with cancer of the face, cancer of the anus grows rapidly. The superficial tumor spreads more upon the skin than on the mucous membrane, so that it may completely surround the anus and extend to the sacrum or to the vagina. The deep-growing tumors extend further into the anal canal, where they project as cauliflower-like masses. The inguinal lymphatic glands and the glands about the ischiatic nerve are early affected.

Symptoms.—Early in the disease the patient suffers much from pain, especially at defecation. If the tumor affects the sphincter, incontinence may follow.

Prognosis.—The prognosis is grave on account of the rapid growth of the tumor and the early infection of the lymph-glands.

Treatment.—In order to achieve success the treatment must be radical. Even if the patient is seen at an early stage, the whole anus, the sphincter muscle, and a part of the true rectum must be sacrificed, and the lymph-glands in both inguinal regions removed. The details of this operation are given on page 157.

Benign Tumors of the Rectum developing from Connective Tissues.

Benign tumors which develop in the connective tissue or in the muscular tissue of the rectum are lipomata, myomata, and fibromata. The fibromata are usually small, from the size of a pea to that of a filbert, and situated beneath the mucous membrane, which they push before them into the lumen of the rectum. Senn mentions a case of fibroma weighing twelve pounds. They may be more or less pedicled. In the same situation are found myomata and myofibromata, but they are not so common as the fibromata. Myomata may also grow upward and develop in the perirectal tissues to a very great size, so that they compress the rectum. According to their situation they may become prominent below the sacrum or may extend upward into the abdominal cavity. The incision for their removal will vary accordingly. Whatever the direction and growth of the tumor, it will have at one point so close an attachment to the wall of the rectum that the bowel will be opened in its removal. This opening must be closed by suture.

An angioma of the mucous membrane is a rare tumor which may give rise to troublesome hemorrhage.

The malignant connective-tissue tumors of the rectum are round and spindle-cell sarcomata. They may spring from the posterior wall of the rectum above the sphincter or from the anterior wall in the vicinity of the prostate and bladder. Such a tumor may be simple or nodular. It carries the mucous membrane into the lumen of the bowel, which it somewhat displaces. Ulcer and gangrene may develop at the summit of the growth. The rectal and inguinal glands are early affected. The prognosis of such a tumor is bad, especially if it is of the melanotic type. However, removal has been followed by permanent recovery.

Echinococcus cysts have been found in the neighborhood of the rectum, and dermoid cysts also occur in this vicinity. A dermoid is usually situated above the levator ani muscle, behind and to the left side of the rectum.

Benign Tumors developing from the Epithelial Portion of the Rectum.

Adenoids or Mucous Polyps.—A polyp is spoken of on the preceding page as a tumor which develops in the wall of the rectum, and pushes the mucous membrane into the lumen of the bowel. Such a tumor is a fibroma. In the section on Catarrh of the Rectum inflammatory polyps are spoken of as developing in part from new-formed granulation-tissue and in part from mucous membrane. This mucous membrane may show degenerative change and loss of its tubular glands, or it may show the progressive changes of glandular hypertrophy. The glands of Lieberkühn may grow longer and wider, and change from simple tubular glands to more or less racemose glands. All of the additional branches and tubes are still lined with a single layer of cylindrical epithelium. The new growth may therefore be spoken of as an adenoma. Such productive changes are usually circumscribed, and the result is a well-defined little tumor which is dragged more and more into the lumen of the bowel. It may be spoken of as a polypous adenoma or an adenomatous polyp. All adenomata of the rectum are not polyps. Sometimes a broad, flat form is seen situated usually just above the limit of the stratified epithelium. As long as an adenoma does not grow beyond the mucous membrane it is a benign tumor.

Mucous polyps are usually found in the lower third of the rectum, especially in the posterior raphe. Usually only a single one exists, and its size is rarely larger than that of a filbert. Its general appearance and color are like those of a strawberry or raspberry. Children and young persons are chiefly affected.

Symptoms.—If a polyp is small and single and does not reach into the anal canal, it may give no symptoms. If, however, it is irritated

PLATE IV.

agittal Section of Rectum, showing Numerous Mucous Polyps and Ulceration of the Mucous Membrane. (Schreiber.)

by the passage of fecal matter, or is sufficiently long to reach into the anal canal, there will be tenesmus with frequent hemorrhage from the easily injured surface of the soft polyp. If the pedicle of the polyp is very long, the mass may remain constantly outside of the anus; or if the pedicle gives way, spontaneous cure may result. If many polyps are present, repeated injuries to them may incite chronic catarrh. A mucous polyp may undergo cancerous degeneration, but this is extremely rare.

Diagnosis.—The diagnosis may be obscure in the case of children, who describe their symptoms indefinitely. The local examination will usually reveal the cause of the symptoms.

Treatment.—The only treatment worth considering is operative. If the polyp is prolapsed, it is easily removed. If it is situated higher up, it may be removed through the rectoscope by special instruments, or the anus and sphincter may be dilated under general or local anæsthesia, and the tumor exposed through a speculum. If the pedicle is thin, it should be clamped near the base and ligated with a stout ligature in order to prevent the sharp bleeding which often follows this division. If the tumor has a broad base, it should be removed with the underlying mucous membrane in such a manner that the oval defect can be closed by suture.

Polyposis Recti.—Cases have been described in which the mucous membrane of the whole rectum and, indeed, of parts of the large intestine as well, are covered with mucous poloyps.

Pathological Anatomy.—The mucous membrane is covered with polyps the size of a pea or smaller, which are so close together that they form a continuous nap, like the nap of a carpet. Here and there will be seen larger polyps varying in size from that of a filbert to that of a fist. Microscopically the smaller polyps give the appearance of glandular hypertrophies, and the larger ones the appearance of adenomata. The sphincter shows the signs of chronic inflammation. In most of the cases described this disease has affected young children. It also shows a tendency to occur in different members of the same family.

Symptoms.—The usual symptoms of chronic catarrh of the intestine are present, with an abundant mucous or bloody discharge which causes distressing tenesmus and even incontinence. If the polyps are large enough, they may give rise to symptoms of stenosis; if they prolapse through the anus, they are extremely painful; and if they become eroded or ulcerated, they may occasion dangerous or even fatal hemorrhage. A patient with this trouble grows gradually thinner and very anæmic, and usually dies in from two to ten years. In about one-half of the recorded cases the adenomata have developed into carcinomata.

Prognosis.—The prognosis of polyposis is not favorable. In six of the eighteen published cases death occurred from exhaustion, hemorrhage, or invagination of the large intestine into the rectum. In six other cases carcinoma developed in the polyposis and rapidly produced death.

Treatment.—Larger polyps should be removed as far as they are accessible, and treatment for the chronic catarrh should be instituted. An artificial anus at the sigmoid flexure in order to free the affected rectum from the passage of fecal matter will be of little service if the large intestine shows marked alteration. As this is usually the case, a more radical operation is to establish an anastomosis between the ileum and the rectum, and so free the whole large intestine from the presence of feces. The improvement obtained by such measures is likely to be only temporary.

Papillomata of the Rectum.—A rare form of polypoid disease of the rectum is one in which a soft reddish tumor with a short, broad pedicle is covered with fine, thread-like processes which float in water. These papillæ are joined together in groups, and these groups are joined at their bases. Such a papilloma bears a strong resemblance to a mucous polyp, but it may easily be mistaken for a papillary cancer. Within the papilloma is a connective-tissue framework which extends from the pedicle into all the papillæ and carries an abundant supply of bloodvessels. The surface of the tumor is covered with either a normal or an adenomatous mucous membrane.

These papillomata have a slight tendency to degenerate into cancers (3 times in 40 cases). They are found almost exclusively in adult life, especially between forty and sixty years. This is in sharp contrast with mucous polyps, which are especially common in childhood. Men and women alike are affected.

Symptoms.—The symptoms resemble those caused by mucous polyps, but the papillomata bleed freely and frequently cause diarrhœa and prolapse of the rectum. The different ages of the patients affected by mucous polyps and by papillomata should serve to distinguish these growths; a papilloma can be distinguished from a cancer by the lack of infiltration of its base, even though it is sessile. Sarcoma, on the other hand, is firm and has a smooth surface.

Treatment.—The tumor should be removed in the manner described for the removal of a mucous polyp. If there is a suspicion of carcinoma, a larger portion of the tissue at the base of the tumor should be removed with it.

Malignant Epithelial Growths of the Rectum.

Carcinoma.—**Pathological Anatomy.**—Carcinoma of the rectum proper is made up of cylindrical cells like the epithelium from which it grows. Adenoma of the mucous membrane of the rectum may develop from the cylindrical epithelium which lines the crypts of Lieberkühn. Without any change in its anatomical structure such a benign tumor may extend beyond the level of the mucous membrane into the sphincter and other layers of the rectum and produce metastases. Such a tumor is called a malignant tumor. Microscopical examination of a portion of it will give no evidence as to its

PLATE V.

Ulcerated Epithelioma of the Rectum.
(Quenu and Hartman.)

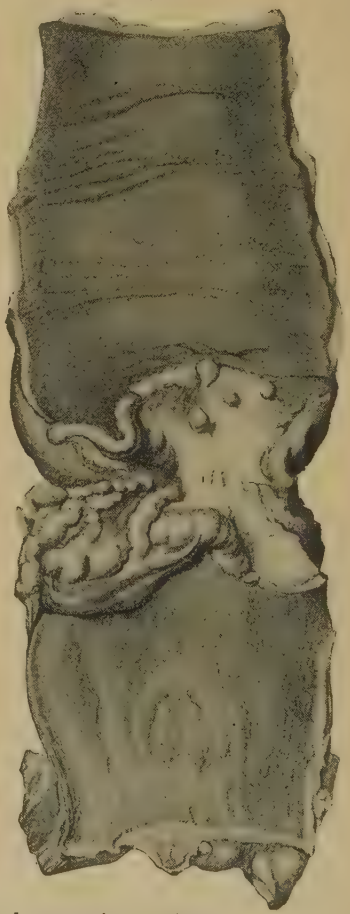
and less often on the side wall of the rectum. As such a tumor grows it extends circularly until it envelops the whole circumference of the rectum. In about three-fourths of the patients seen by Mikulicz the tumor had advanced to this condition. Lorenz mentions 34 circular tumors and 47 isolated ones.

The second group of carcinomata consists of fibrous tumors situated high up above Douglas's pouch, at least 5 to 8 cm. (2 to 3.2 inches) above the anus. These scirrhous tumors are usually as large as a walnut or a small egg. Very early they envelop the circumference of the bowel and produce symptoms of stenosis. They rarely extend along the bowel more than 4 to 7 cm. (1.6 to 2.8 inches). (Fig. 48.) This second group of

FIG. 47.

Carcinoma of the ampulla of the rectum. Nearly circular.

FIG. 48.



Scirrhous carcinoma of the upper portion of the rectum.

tumors comprises 23 per cent. of the whole. Of 36 high-seated tumors mentioned by Lorenz, all but 5 had formed a stenosing ring.

In the third group of rectal carcinomata are those tumors which infiltrate a considerable part of the rectum from the beginning, or, at least, very early in their growth. They constitute from 12 to 15 per

cent. of rectal carcinomata. Such a tumor may be of gelatinoid or mucoid nature. It envelops especially the lower part of the rectum, spreads superficially, and at the same time extends rapidly into the deeper tissues. The rectum is therefore changed into a narrow inelastic cylinder the size of whose lumen may be increased by necrosis and disappearance of cancer masses. Such a rectum will appear as a gaping cavity with hard walls and partly filled with blood and gangrenous material.

In order to make this subject complete, it should be mentioned that a carcinoma may develop outside of the rectum from remains of the embryonic structure called the "post-anal intestine." Such a tumor starts behind the rectum in the hollow of the sacrum, and being covered by a normal mucous membrane can easily be mistaken for a sarcoma.

Carcinoma in the rectum, as elsewhere, grows both superficially and deep; but, except in the case of gelatinous and other soft tumors, the extension of the growth beyond the wall of the rectum itself first occurs at a late period. In this manner the prostate, bladder, urethra, vagina, uterus, sacrum, and the whole of the pelvis may be involved in the new growth. At the same time metastases occur in the course of the lymph-channels. Funke found lymph-glands affected in two-thirds of the patients operated upon. Probably the real figure is even greater. Such secondary inflammation occurs very early in gelatinous and other soft growths, and relatively late in scirrhous carcinoma. The presence of infected lymph-glands and their exact situation are of the greatest importance in the operative treatment of rectal carcinoma. Gerota mentions the following areas of distribution of the lymphatic vessels: 1, the skin of the anus; 2, intermediate zone of the anal portion; 3, the columnar zone of the anal portion; 4, the true rectum. The lymphatics of the third and fourth territories correspond to the superior hemorrhoidal artery and vein which reach to the lower end of Morgagni's columns. The lymphatics of the intermediate zone freely anastomose with those of the territories above and below. There are no lymph-glands in the wall of the anal portion of the rectum; they are very abundant in connection with the true rectum. In the extraperitoneal portion from the attachment of the levator up to Douglas's pouch, the lymph-glands are situated especially on the side of the rectum between the muscular layer and the fascia of the rectum proper, this space being filled with fatty tissue. The lymph-glands follow the branches of the superior hemorrhoidal vessels. Higher up, where the sides of the rectum are covered with peritoneum, the glands are placed farther and farther back, following the course of the hemorrhoidal vessels until they are situated wholly in the mesorectum.

The lymph from the anal skin flows through five or six lymph-vessels which run along the inner surface of the thigh to the inguinal glands of Scarpa's triangle. The lymph-vessels from the columnar zone of the anal portion run to the glands at the side of the extraperitoneal part of the rectum. Gerota calls these glands, therefore, the

"anorectal glands." This is the regular plan of lymph circulation. In exceptional cases the vessels follow the middle hemorrhoidal artery and terminate in a hypogastric gland on the side of the pelvis near the sacrosciatic foramen. The lymph-vessels of the mucous membrane proper run to the glands situated laterally below the peritoneal reflection—that is to say, to the anorectal glands, and also to the glands in the sigmoid mesocolon. By means of the anastomoses which invariably exist the lymphatics from the anal skin may drain into the anorectal glands and thence into the rectal glands.

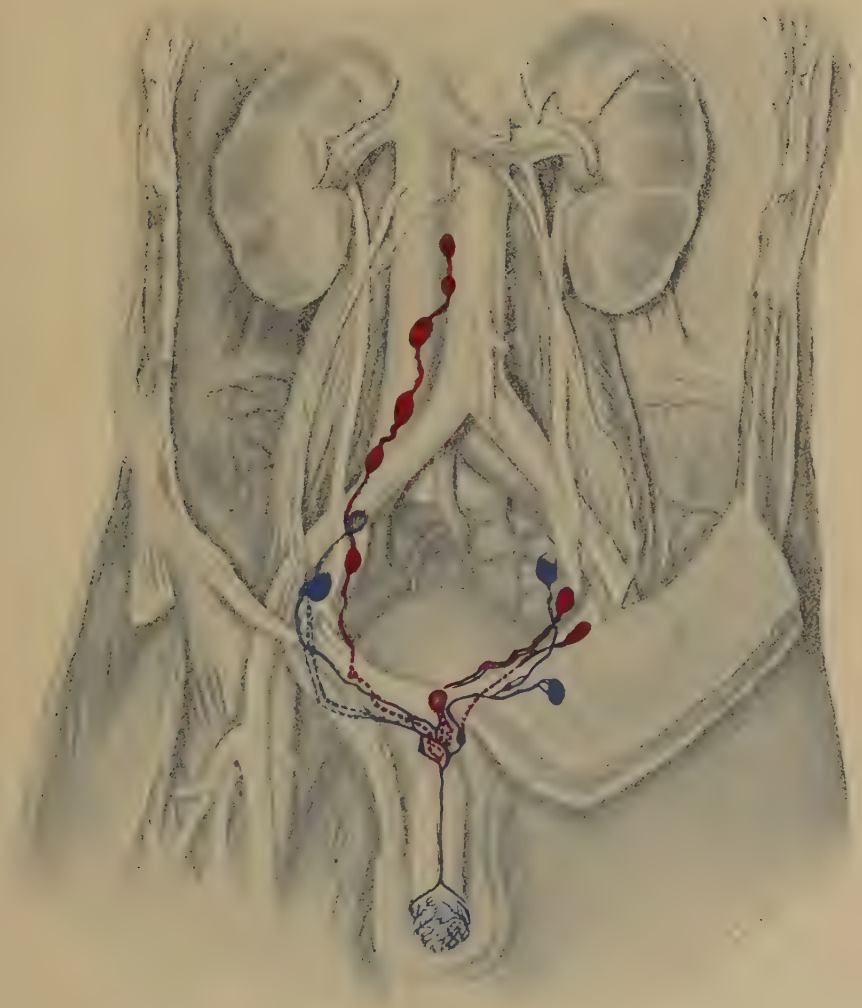
Etiology.—Little is known of the etiology of rectal carcinoma. Heredity plays apparently little part (4–12 per cent.). Oft-recurring slight injuries and irritations such as are due to hemorrhoids, fissures, chronic catarrh, ulcers, strictures, etc., may furnish the basis for the development of carcinoma. But such a sequence of events has been seldom noted.

Carcinoma of the rectum, according to Christen, causes about 0.3 per cent. of deaths. It is almost twice as common in men as in women. In 70 per cent. of the cases the age of the patient lies between forty and seventy years. It is a remarkable fact, however, that rectal cancer occurs also in children, even in those less than ten years of age, which may perhaps be explained by the frequency of adenoid growths in children. Gelatinous cancer is almost exclusively found in young persons; only 1 of 21 persons affected was more than thirty years old. (Funke.) From 2 to 3 per cent. of all cases of rectal carcinoma occur in persons between twenty and thirty years of age.

Symptoms.—In its early stage carcinoma of the rectum produces few or no symptoms, or, possibly, a slight heavy feeling during defecation. The first marked symptoms appear with the ulceration and stenosis, and this occurs relatively early, as in all cases of carcinoma of the intestine. The existence of an ulcer is shown by the passage of mucus and small quantities of blood. This is noted in at least 90 per cent. of all cases of carcinoma of the rectum. The amount of discharge may increase rapidly if the cancer is soft, more slowly if it is hard. The discharge is scanty in the fibrous forms, in which the stenosis is so marked. At first the normal fecal mass is somewhat smeared with mucus and streaks of blood. Later there is a further discharge of bloody, purulent, vile-smelling fluid, with fragments of partly degenerated carcinomatous tissue. A short time after the rectum has been emptied this material again collects and often produces tenesmus. If the cancer is soft, there may be in addition a discharge of free blood which very much weakens the patient.

Symptoms of stenosis are more prominent with fibrous carcinoma, especially if situated high up. Possibly the first symptom noticed is an obstinate constipation lasting for several weeks, which is only partially overcome by strong cathartics; or the patient may complain of a feeling of weight and pressure in the rectum and sacrum. There may be symptoms of ileus, and possibly invagination of the circular

PLATE VI.



Showing Lymphatics of Penis, some of which Pass Around the Inguinal Directly into the Pelvic Glands. (Kuttner.)

carcinoma into the lower part of the rectum. Constipation may alternate with diarrhœa if the fecal matter retained above the stricture is soft and slowly trickles through the narrow opening.

The softer forms of cancer also give rise to symptoms of stenosis, even though they do not involve the whole circumference of the bowel. In any case the new growth makes the rectum stiff and less capable of expelling the fecal masses. In the later stages the destruction of tissue may relieve the stenosis. As the fecal masses, gangrenous débris, and bloody fluid collect in the lower part of the rectum the patient may experience an uncontrollable desire to defecate, perhaps as often as every fifteen minutes during the day, and at frequent intervals during the night. The sphincter muscle may become so weakened that partial incontinence exists. If the cancerous growth extends into the muscle, there may be complete incontinence.

In the early stage of carcinoma of the rectum the patient's general health may not be affected. He may keep his color and good appearance until ulceration and symptoms of stenosis set in. A chronic septic condition may be produced by the resorption of gangrenous fluids and retained fecal masses. Such a patient will feel weak and sleepy, incapable of work, and will lose appetite for food. There will be a steady appreciable loss in weight, and the skin will assume more and more a typical cachectic color. In the later stages the pain caused by the growth of the tumor into the surrounding organs will help to exhaust the patient. Such pain is especially severe in the bladder and sacrum, and added to the tenesmus and loss of sleep and the constant soiling of the clothing, it brings the patient to a deplorable condition. Perforation of the carcinoma into the peritoneal cavity, or into the bladder, or erosion of a large bloodvessel may suddenly terminate life.

The duration of life in rectal carcinoma varies according to the structure of the tumor. In the scirrhous forms it is from three to five years, while in the medullary and gelatinous forms it is from one to two years. The tumors which develop in young persons show in general a greater malignancy than those which affect patients in middle or advanced life.

Diagnosis.—The diagnosis is easily made. If the tumor is in an early stage, one feels an isolated ulcer with a margin as hard as cartilage, made up of separate nodules as large as a pea, or larger, which are sharply contrasted with the soft surrounding mucous membrane. This infiltrated margin is 1 to 2 cm. (0.4 to 0.8 inch) broad, and can hardly be mistaken for the smooth soft border of a simple granulating ulcer due, for example, to syphilis or gonorrhœa. At a later stage the ulceration may extend around the whole circumference of the bowel, which will then feel like a stiff narrow tube, with a hard, rough, irregular wall. The gelatinoid cancers are much softer, but here, too, the ulcer may be felt to be surrounded by an extensive infiltration in contradistinction to a simple ulcer. The fibroid cancer is more difficult to diagnosticate, even though it is within reach of the finger. It is charac-

terized by normal mucous membrane close up to the tumor, and accordingly palpation will show the uneven formation of the new growth as contrasted with the contracted, smooth, funnel-shaped scar of the cylindrical stricture. In doubtful cases a section should be removed for microscopical examination.

If a carcinoma situated high up is invaginated into the lower portion of the rectum, it appears like the cervix uteri. If a carcinoma is situated so high up that it cannot be reached with the finger, the patient should be examined standing and directed to press downward. This may bring the tumor within reach. The collection of a large quantity of feces above the tumor may also press it downward, although it is well out of reach when the bowel above is empty. Hochenegg says that in carcinoma of the rectum situated high up the walls of the ampulla do not lie naturally in contact. The ampulla is full of air, so that its side walls cannot be touched until the examining finger is flexed. The proctoscope and general anæsthesia are invaluable aids to diagnosis in difficult cases. Examination by means of the sound is dangerous.

The shape of the fecal masses which are passed from the rectum is of no value in the diagnosis. Some idea of the situation of the carcinoma may be gained from the amount of water which the rectum will contain; but this test may be misleading on account of a flow of water past the stricture.

Sarcoma differs from carcinoma in forming a more spherical, softer tumor, which lies outside of the mucous membrane. The tumor is covered with unaffected mucous membrane up to the time when degenerative processes arise.

In spite of the ease with which diagnosis of carcinoma of the rectum is made, even in the early stages, surgeons rarely see a patient until the disease has become well advanced. This is partly due to the fact that the early symptoms may be slight, but it is partly due, unfortunately, to the fact that the physician first consulted misinterprets the constipation or diarrhœa, or slight loss of blood, and neglects the all-important digital examination. There is also a mistaken belief that a patient with carcinoma of the rectum must have a cachectic appearance. It cannot be too strongly insisted upon that these patients in the early stages may look perfectly well, since the cachexia is due to the severe pain, loss of blood, and chronic sepsis which underlies the development of stenosis.

Treatment. — INDICATIONS FOR A RADICAL OPERATION.—Some men, such as Routier, Rose, Swenson, and others, say that carcinoma of the rectum is an incurable disease, and should be treated only by palliative measures; but the statistics given by reliable surgeons disprove this pessimistic view. It must be admitted that a considerable number of the patients who are operated upon suffer from recurrence of the carcinoma, but this is due not to the nature of the growth, but to its extent at the time of operation. Consequently the majority of surgeons to-day look upon rectal carcinoma as operable under certain cir-

cumstances. It is important to know just what these circumstances are. In the first place, the situation of the tumor, whether high or low, is no counterindication to operation. Of the tumors which are situated high in the rectum, those may be considered inoperable which have extended to the sacrum, promontory, bladder, or uterus, both because of the great difficulty of controlling the hemorrhage during the removal of such an extensive new growth, and because of the probability that some of it will be left behind. If the tumor is situated in the lower part of the rectum, it should not be considered inoperable on account of slight adhesions to the sacrum, prostate, seminal vesicles, or vagina. Opinions differ as to the advisability of operation if the tumor has involved the bladder or the urethra, even though success under such circumstances is sometimes obtained. Such an operation is not to be recommended, because the extensive removal of tissue produces incontinence of urine and the probability of recurrence is very great. In determining whether adhesions to the sacrum are sufficient to render operation inadvisable, narcosis is often necessary. If the attachment to the sacrum is a very close one, no radical operation should be attempted. In doubtful cases an exploratory laparotomy will reveal the relation of the carcinoma to the bladder, to the peritoneum, to coils of intestine, and to the promontory, and will also reveal the presence of enlarged retroperitoneal glands. If this condition is found to be unsuited to radical operation, the peritoneal incision may be utilized for an artificial anus. If radical operation is indicated, the abdominal incision permits the operator to free the tumor from above before attacking it from below (abdominosacral method). The existence of metastatic nodules, especially in the liver, or in the remote lymph-glands along the spinal column or above the colon, of course make a radical operation impossible; but even when metastases are present, it may be desirable to remove the primary disease; for example, if it causes symptoms of ileus, or if it is so small that its removal is preferable to an artificial anus. Age is no counterindication, as patients between seventy and eighty years of age have been operated upon many times with success.

Preparation of the Patient for Operation.—The wounded surface will be able to protect itself in from five to eight days. If it is contaminated with fecal matter earlier than this, fatal infection is the result; hence the importance of a thorough emptying of the intestine before operation. In many cases the tumor obstructs the intestine so that it will require a daily treatment for one or two weeks in order to clear the passage completely. Every morning before breakfast half an ounce or more of castor oil should be given, and followed by an enema. Palpation of the abdomen will sometimes show whether the intestine is empty, and the urine should be tested daily for indican. Cathartic treatment should be continued as long as a positive reaction is obtained when sulphuric acid is added to the urine. Articles of food which leave a residue should be forbidden, and the patient should be given

chiefly meat, eggs, and strong soups. For two days before operation he should be placed upon a liquid diet and given opium. The last enema should be given not later than six hours before operation.

Hochenegg has departed from this method of preparation, and gives his patients a diet which will produce solid feces, claiming that diarrhœa is more dangerous than the passage of solid fecal masses. This plan has not been generally adopted.

The patient is given a warm bath, placed upon the operating-table, and irrigated with lysol in such a manner that the fluid flows out immediately. The skin is then prepared in the usual manner. If the stricture of the rectum interferes with the proper carrying out of the operation indicated, an artificial anus should be established. Schede and a few other surgeons establish an artificial anus as a preliminary step in every case. Made through an incision to the left side on a level with the umbilicus, the lower portion of the descending colon can be opened. The sigmoid flexure will then be left free to be drawn downward after removal of the tumor.

If a preliminary colostomy is performed, two weeks should elapse before the radical operation is attempted. In this time the intestine can be thoroughly emptied and the general condition of the patient improved.

Methods of Operation.—*Partial Excision.*—A portion of the circumference of the bowel may be removed if the tumor is not more than an inch in diameter and is easily accessible through the anus. The patient is anæsthetized, placed upon the back, and the sphincter is dilated or divided posteriorly by a cut from the anus to the coccyx. The anal canal and the ampulla of the rectum are then easily accessible. The new growth is seized with clamps and drawn forward and excised with knife or scissors, together with a margin of healthy tissue 2 to 8 cm. (0.8 to 3.2 inches) wide. Bleeding is carefully controlled and the gap sutured transversely in order to avoid narrowing of the rectal lumen. The posterior cut is drained with iodoform gauze and the tube left in the anus.

Partial excision even for a very small tumor is not advisable on account of the early infection of the neighboring lymph-vessels and glands. Thus a growth situated anteriorly or posteriorly infects very early the glands which are situated on the side or back wall of the rectum. Such glands will not be removed by a partial excision, and there will be in consequence an early recurrence of the growth. Furthermore, this method of operating in the case of benign tumors and sarcomata has its disadvantages, since the pelvirectal connective tissue is apt to become affected unless iodoform gauze is used for drainage.

Circular Resection of the Rectum.—Radical removal of even a small part of the rectum is best accomplished by resection of a cylinder of the bowel, together with the accompanying infected glands. If the tumor is situated within or below the sphincter, this muscular structure

must also be removed, together with a greater or less portion of the rectum; hence the operation has been called "amputation of the rectum." If the tumor is so extensive that both the anal portion and most of the true rectum have to be removed, the term "extirpation of the rectum" is used, although these two terms are often confounded. The operation is designated "resection of the rectum" if the carcinoma is situated so high that the sphincter muscle can safely be left. In this case a cylindrical section of the rectum is removed and the central and peripheral ends are united.

Excision of the rectum is a general term to indicate removal of the affected portion irrespective of its situation.

The simplest method of attack of a rectal tumor is to expose its lower portion by an incision in the perineum—the perineal method. This is adapted to the removal of tumors situated low down. Those higher up are more accessible through an incision made posteriorly in the region of the coccyx and sacrum. This method is called the sacral or dorsal method, and is now employed much more frequently than the perineal. The tumor, if occurring in a woman, may be removed by an incision which divides the vagina and perineum—the so-called vaginal method. If the tumor is situated in the upper part of the rectum or in the sigmoid flexure, it may be removed through an abdominal incision, hence the name abdominal method.

Perineal Method.—The perineal method usually gives sufficient room for the dissection of the perineal and pelvic portions of the rectum. It is especially employed for amputation of the rectum when the sphincter is sacrificed.

The patient lies in the lithotomy position with the hips elevated. The anus is closed by a water-tight suture. An incision is made 3 or 4 cm. (1.2 or 1.6 inches) from the anus, and encircling it. Dieffenbach and Velpeau gain more room by a longitudinal incision in the perineum, and another from the anus to the coccyx.

The dissection of the rectum is begun in front in order that the surgeon may early see if the prostate is involved, and whether the tumor is one which can be radically removed. The subcutaneous fat is divided, and the attachment between the external sphincter and the transverse perineal and bulbocavernosus muscles is cut across. The edges of the wound are pulled strongly apart front and back, and guided by a silver catheter in the urethra, the surgeon frees the urethra by blunt dissection as far as the prostate. The fascia covering the levator muscle must be cut through. If the carcinoma has not involved the prostate, this gland can be readily separated from the rectum by the finger. If the two structures are attached by the new growth, the dissection is difficult, and should not be proceeded with until the surgeon has made up his mind that the tumor can be radically removed.

The incision is deepened laterally to the levator ani muscle, the branches of the inferior hemorrhoidal branches of the pudic arteries being ligated. Posteriorly the fat is cut through until the attachment

of the levator ani to the coccyx is exposed. Some surgeons split the rectum in order to get a better view of the tumor, but it is safer to remove it as a closed sac, and thus to avoid infecting the wound with its contents.

The levator ani muscle will now be exposed all the way round. It should be cut through not too close to the intestine. Immediately above it is the firm fascia of the pelvis, which should likewise be divided circularly. This cut opens the pelvirectal space and frees the true rectum.

The dissection anteriorly is much easier in women because it can be controlled by the finger in the vagina. When the union of the internal sphincter and the constrictor cunni is cut through and numerous large veins are ligated, the loose connective tissue of the rectovaginal septum is reached and easily torn through with the finger.

The true rectum is readily freed by blunt dissection. The bowel is drawn downward and forward and the surgeon works his fingers upward posteriorly until the third or second sacral vertebra is reached. The dissection is continued laterally, where the branches of the middle hemorrhoid will require ligation. As the fingers tear through the fat certain resistant bands are felt containing the vessels. These should be divided between ligatures passed around them by a blunt curved needle. Only separation of the prostate and seminal vesicles remains. The lowest portion of Douglas's pouch lies about 1 cm. (0.4 inch) above the upper border of the prostate. If the tumor does not involve this portion of the rectum, the peritoneum may be stripped from the bowel for a considerable distance, thus allowing much more of the rectum to be drawn downward. If the rectum cannot be loosened in this manner, it will be necessary to divide between ligatures the branches of the superior hemorrhoidal artery behind the rectum and to cut into the peritoneal reflection anteriorly. The incision into the peritoneum is extended laterally as far as possible and then temporarily filled with gauze. By proceeding in this manner the rectum can be brought down far enough to be cut off 3 or 4 cm. (1.2 to 1.6 inches) above the tumor and stitched to the skin about the anus. With proper aseptic precautions no peritonitis should follow the opening of the abdominal cavity. The position of the patient with elevated pelvis makes a prolapse of intestinal loops unlikely.

When the bowel is loosened to such an extent that it can be brought out of the wound without tension and all hemorrhage is checked, the opening in Douglas's pouch is sutured to the anterior surface of the rectum. The needle should be passed longitudinally, and not transversely, in order to avoid including the vessels whose blood-supply may be essential to the life of the bowel. If this suture is a difficult one, and will require too much time, it may be omitted and the opening packed with weak iodoform gauze. The rest of the wound should be tamponed in the same manner. The cutaneous wound should not be sutured, in order that all secretion may escape.

The next step is to attach the bowel 3 to 4 cm. (1.2 to 1.6 inches) above the new growth to the skin on one side, or on both sides if one is careful to arrange the iodoform gauze in such a manner that it can be removed without interfering with the sutures. The bowel must be so loose that there is no strain on these sutures; otherwise they will cut through and the bowel will retract, and a stricture will follow cicatrization. When the suture is completed, the wall of the rectum, with the exception of the mucous membrane, is divided with a knife and any bleeding vessels are ligated. The mucous membrane is then ligated with silk and divided with a thermocautery. In this manner infection of the wound is avoided. The ligature cuts through the mucous membrane in about three days, the contained gas escapes, and thereafter the wound must be regularly dressed. (For the methods of establishing an artifical anus, see Vol. IV., page 460.)

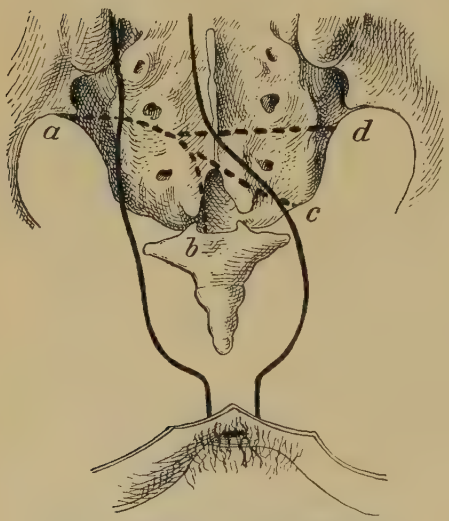
The dorsal method is more and more used, to the exclusion of the perineal, by some surgeons, who employ the latter only for tumors of the anal canal. (Kraske, Hochenegg, Mikulicz.) Others employ the perineal method for all tumors whose upper margin can be passed by the examining finger. (Czerny, König, Küster, Quénu, Block, and others.) They claim that it is less dangerous and gives a shorter convalescence. It is not suited to deep-seated new growths in which there are adhesions or infected glands in the mesorectum. Under these circumstances the sacral method gives the surgeon a better chance to perform a radical operation.

Dorsal Methods.—The posterior route gives freer access to the rectum than the perineal. A glance at a pelvis divided in the sagittal plane shows that from anus to coccyx the rectum is surrounded by soft parts (internal sphincter, levator, and coccygeal muscles), whereas higher up it is in intimate contact with the coccyx and sacrum. The rectum is therefore easily freed throughout its lower two-thirds by an incision through these soft parts and bones. Kocher in 1874 adopted this dorsal route for the removal of carcinoma of the rectum, making an incision from the anus to the sacrum and removing the coccyx. In 1889 Zuckerkandl and Wölffler extended this incision higher by separating the glutæus muscle and the sacrosciatic ligaments from the sacrum. In 1885 Kraske gained a still freer access to the rectum by resecting a part of the sacrum. The nerves which may be injured during this operation are the third, fourth, and fifth sacral nerves, which emerge from the third and fourth sacral foramina, and the articulation between the sacrum and coccyx. The posterior branches of these nerves have no special significance. The anterior branches form numerous anastomoses and supply the contractile muscles of the anus and bladder. It has, however, been repeatedly shown that both the fourth and fifth sacral nerves on both sides, and even the third sacral nerve on one side, may be divided without injury to the rectum and bladder. The opening of the sacral canal is not apt to be followed by septic meningitis, so that the surgeon need not fear this complication.

The steps of a dorsal operation are as follows:

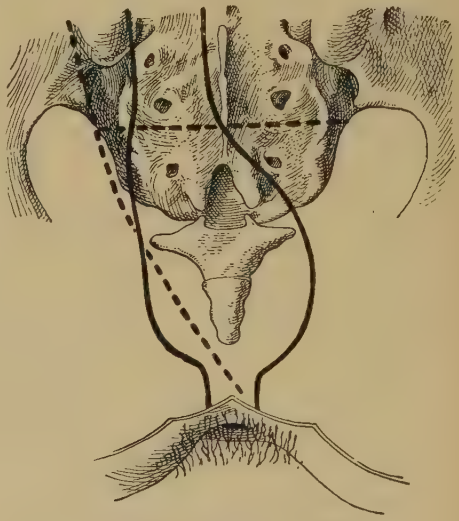
Exposure of the Rectum.—The patient lies upon the right side with the thighs sharply flexed. An incision is made in the middle line from the anus to the sacrum, and from there along the left border of the sacrum to the posterior iliac spine. The glutæus maximus muscle is divided close to the sacrum and numerous arteries are ligated. The sacrosciatic ligaments are next exposed and divided close to the sacrum almost up to the sacro-iliac synchondrosis. The lateral sacral arteries are ligated and divided, or compressed with sharp hooks. In the upper angle of the wound lies the pyriform muscle. Its lower half may be divided if necessary. On its anterior surface, 2 or 3 cm. (0.8 to 1.2 inches) above its lower

Fig. 49.



Incision of Kraske, *a–b*; Hochenegg, *a–c*; Bardenheuer, *a–d*.

Fig. 50.



Incisions of Rehn-Rydygier.

Sacral exposure of the rectum.

border, lie the pudic nerve and vessels. These should not be injured. In the lower portion of the wound are the coccygeal and levator ani muscles. These are next separated from the margin of the coccyx. The rectum is now exposed covered only by the pelvic fascia. It is even more accessible if the coccyx is removed. This is accomplished by separating from it the skin and dividing the muscles which are attached to its right side. The pelvic fascia can then be pushed from the anterior surface of the bone. The median sacral artery may require ligation. The coccyx may be temporarily resected by separating it from the sacrum with a chisel and drawing it with the attached soft parts to the right side, or it may be removed.

By division of the sacrosciatic ligaments and removal of the coccyx the rectum is freely exposed up to Douglas's pouch, or even higher. In order

to remove a tumor situated still higher up a portion of the sacrum must be sacrificed. This is done by dissecting from its posterior surface the skin and subcutaneous fat and pushing the soft parts away from its anterior surface. A portion of the bone may then be removed by the chisel, saw, or, better, forceps (Fig. 49, *a-b*), as high as the third sacral foramen. In especially difficult cases the line of division of the sacrum may extend more transversely (Fig. 49, *a-c* and *a-d*). This requires the previous division of the muscles and ligaments which are attached to the right side of the bone.

Temporary resection of the sacrum has certain advantages over older methods just described. The incisions recommended by Rehn-Rydygier are shown by dotted lines in Fig. 50. The same division and

FIG. 51. FIG. 52.

Incision of Heineke. Incision of Levy-Schlange.

Sacral exposure of the rectum.

blunt dissection of the soft parts are required for this operation as for the resections previously described, except that the skin and muscles are not removed from the back and right side of the sacrum, and that a transverse cut is made through the skin at the place where the bone is to be chiselled through transversely. The flaps of skin and bone can then be reflected to the right.

Heineke makes a median incision over the coccyx, which he saws through from top to bottom and disarticulates from the sacrum. The two parts of the coccyx and the soft parts are then drawn to the right and left and the rectum exposed. (Fig. 51.) If necessary, a portion of the left side of the sacrum may be removed with a chisel.

Another osteoplastic operation which is advocated by Levy and Schlange is pictured in Fig. 52. The sacrum is exposed at the level

begins to separate the bowel above, claiming that ligation of the superior hemorrhoidal vessels makes the rest of the operation almost bloodless. The posterior wall of the bowel is freed first, and then the lateral attachments are ligated and divided. The abdominal cavity is opened on both sides of the rectum and the hand of the operator passed into it. With the assistance thus gained the vessels of the mesorectum and mesosigmoid can be ligated and divided until the whole rectum, and, if necessary, a considerable part of the sigmoid flexure, can be brought out of the wound. The openings into the peritoneal cavity are then tamponed, and the reflection in Douglas's pouch is incised transversely in order to permit separation of the bladder, prostate, and seminal vesicles from the rectum. This is accomplished by blunt dissection and with scarcely any loss of blood.

Care of the Bowel after Resection.—When the intestine is sufficiently loosened, the peritoneal cavity is sutured and the suture-line protected with iodoform gauze. The affected portion of the bowel is then resected, the line of incision passing at least 2 cm. (1.6 inches) above it and 2 cm. (0.8 inch) below it. Strong ligatures around the bowel above and below the upper lines of incision will prevent the escape of gangrenous infected material. The bowel is then ligated below the tumor and the anal portion of the rectum sponged dry through the anus. The bowel is then cut through below the tumor and the affected portion removed. In some instances it is best to dilate the sphincter, invaginate the tumor, and bring it out of the anus. This simplifies matters very much, since one has only to cut off the prolapsed portion and suture the intussusceptum to the intussuscipiens. If this cannot be done, the suture may be performed in various ways. If the proximal end is long enough, it can be brought out through the sphincter and stitched to the anal skin. Before this is done, the anal portion should be everted and stripped of its mucous membrane. The proximal portion should also be stitched to the upper margin of the sphincter by catgut sutures which do not penetrate its lumen.

Heineke splits the anal portion in the median line posteriorly and removes its mucous membrane before stitching the proximal cut end to the anus. When this has been done, the sphincter should be sutured with catgut.

If the proximal end of the bowel is too short to reach the anus without tension, the mucous membrane of the anal portion is preserved and the cut ends are united by a circular suture. It is most easily accomplished if the proximal end is long enough to be brought out through the anus and stitched to the everted anal portion. After the suture the prolapse is pushed up through the anus, and the bowel can be secured in its permanent place by a few additional sutures.

If the proximal end is too short to be brought out through the anus even temporarily, the circular suture must be carried out in the wound. Kraske begins with the anterior wall and stitches first the muscular coat and then the mucosa. He then sews the mucosa

throughout the rest of the circumference and afterward the muscular coat posteriorly.

In some instances the proximal end is not loose enough to permit any suture, and a sacral anus is the only resource. Such a condition will rarely exist in the hands of a surgeon who understands how to free the sigmoid flexure.

The sutured ends of the rectum will only unite if they are well nourished. It is important that the proximal end especially shall not be deprived of its mesenteric vessels for too great a distance, and that it shall not be crushed and torn. Mikulicz before making the suture cuts off the edge of the bowel which has been drawn down by the clamps. The upper part of the rectum is supplied by the branches of the superior hemorrhoidal artery which enter it from behind. The sigmoid flexure with its broad mesentery and arching vessels with free anastomosis is much less likely to become gangrenous than the rectum. The flexure can be brought out of the anus without destroying its vitality. There must be no tension on the intestinal suture, however, otherwise the stitches will cut through and the upper end of the bowel will retract; or areas of gangrene may form above the suture and give rise to fistulas. Rave found gangrene in 10 per cent. of cases of circular suture, and in 18 per cent. of invaginations.

Another important point is to protect the wound from fecal infection during the recovery. Hence the advantage of the invagination method. The circular suture carries with it the risk of rupture and entrance of feces into the cavity of the wound; for, unfortunately, such a circular suture, lacking a peritoneal covering, does not heal with the certainty of a circular suture of the small intestine. Furthermore, solid fecal masses may cause the suture-line to give way even when the sphincter has been thoroughly dilated or divided. Indeed, a circular suture usually leaks posteriorly at the first or second defecation; hence the importance of postponing this act until the wound has had time to protect itself with granulations, and the further importance of arranging the gauze packing so that fecal matter can readily escape. A patient upon whom this operation is performed should have no movement of the bowels for eight or ten days after the operation. In every instance the sphincter should be paralyzed by dilatation or division so that its action will not return for at least two weeks.

The risk of these various procedures is shown by Lorenz' statistics: amputation 90 cases, mortality 9 per cent.; invagination 17 cases, mortality 6 per cent.; circular suture 25 cases, mortality 12 per cent.

When the rectum has been amputated or resected, the wound should be lightly tamponed with iodoform gauze. No gauze should be placed in front of the rectum so that adhesions may form anteriorly; then if there is a rupture the fecal discharge will the more readily escape from the posterior wound. If an osteoplastic flap has been made, it should be only partially replaced in order to allow the secretion to escape and to afford room for the gauze packing.

Vaginal Method.—In women who have borne children the rectum can be easily reached through the vagina. This is the natural method by which to perform amputation of the rectum if the tumor has involved the rectovaginal septum, but Rehn and Gersuny have employed this method for resection of the rectum as well, and this method of procedure has been adopted by many other surgeons.

With the patient in the dorsal position an incision is made in the middle line of the posterior vaginal wall from the cervix to the perineum. If amputation is intended, a circular incision is made around the anus and the perineal rectum is freed. It is easy to free the pelvic rectum through the vaginal incision. The lateral attachments of the rectum should be ligated before division, and this procedure is continued backward until the rectum is freed all the way around just above the sphincter ani. If the tumor is situated higher up, the posterior vault is incised, and the peritoneal cavity is opened well to each side of the pelvic colon. This increases the mobility of the intestine and facilitates ligation of the mesocolon.

If resection is to be performed, the incision by the side of the anus is prolonged into the ischiorectal space of either the right or left side, the vagina is separated from the rectum, and the latter is dissected free above the sphincter ani. The higher dissection of the bowel, ligation and division of the vessels of the mesocolon, etc., is carried out while the rectum is drawn well forward toward the symphysis. Some surgeons cut across the rectum after doubly ligating it, so as to facilitate this high dissection, but Rotter has not found it necessary to do so, thereby avoiding infection of the wound. Hemorrhage is not more troublesome than by the dorsal method, and portions of the bowel measuring 15 to 20 cm. (6 to 8 inches) can be readily resected by this method. The cut ends of the rectum are joined by invagination; or, if this is not possible, by a circular suture, and the vaginal incision is partially closed, space being left for the iodoform gauze which is placed in the hollow of the sacrum.

The vaginal method presents one difficulty, namely, that the dissection of the rectum posteriorly cannot very well be carried on above the promontory unless the perineum is cut through. If this is done, the risk of fecal infection of the wound is materially increased.

Abdominal Methods. — In 1883 Czerny made an abdominal incision in order to complete the removal of a tumor which extended too high to be satisfactorily treated by the sacral method. Since 1896 a number of French, Italian, and German operators have adopted this method for the removal of malignant tumors of the rectum. Quénu operates as follows: An incision is made in the middle line of the abdomen and both hypogastric arteries are ligated at the level of the promontory about 3 cm. (1.2 inches) from the median line. The ureter crosses the artery at this point and should be pushed aside. On the left side the mesosigmoid must be incised to permit ligation of the artery. The second step of the operation is the division and ligation

of the mesosigmoid, including the superior hemorrhoidal artery, in order to loosen the flexure sufficiently while leaving it enough of its blood-supply to prevent gangrene. The bowel is next divided between two ligatures by the thermocautery and the cut ends wrapped with gauze and gutta-percha tissue in order to prevent infection of the wound. The proximal end is then passed out through an incision in the left side of the abdomen in order to form a permanent artificial anus. The third step in the operation is the separation of the lower portion of the sigmoid and the upper portion of the rectum. The peritoneum is divided on either side of the bowel, which is then separated from the sacrum and coccyx by a blunt dissection. Douglas's pouch is next cut across and the rectum separated by blunt dissection from the bladder, seminal vesicles, and prostate, or from the vagina, as the case may be. The wound about the rectum is temporarily tamponed and the abdominal incision sutured. The fourth step in the operation is the separation of the rectum from beneath. A perineal incision is made and the whole rectum, together with the sphincter muscle, is removed. When the operation is carried out in the manner described, the risk of infection and of hemorrhage is slight. The disadvantage of a permanent artificial anus may in some cases be avoided.

Some surgeons also look upon the preliminary ligation of the hypogastric arteries as unnecessary.

Trendelenburg makes the abdominal incision in the left side. He omits the ligation of the arteries and then proceeds in the same manner as Quénu until the levator ani is reached. An assistant then passes through the anus a pair of strong forceps, seizes the tumor and drags it out through the anus, aided by pressure made by the surgeon from above. If this invagination succeeds, the assistant cuts off the tumor outside of the anus, and applies a circular suture. The bowel is replaced or draws back of itself, and the wound is drained through the abdominal incision with less delay in healing than when a secondary fistula exists. This is a purely abdominal method.

Other German surgeons combine the abdominal and dorsal methods, beginning dorsally and freeing the rectum as high as possible. Then if the tumor extends too high, or if adhesion to the bladder and small intestine or other complications exist, an abdominal incision is made and separation of the affected portion of the bowel is completed. Before the bowel is opened the abdominal incision is sutured and the resection is completed through the sacral wound.

The tendency in Germany is to avoid as far as possible an artificial anus by utilizing the sphincter muscle. Such an attempt usually succeeds, especially as the risk of infection is very slight, because the bowel is not opened until the close of the operation. If the portion resected is so great that the cut ends cannot be sutured, a sacral anus is preferable to a leaky one.

The abdominal method is indicated:

1. If the carcinoma is situated in the upper part of the rectum, or

the lower part of the sigmoid flexure, or if the separation from the bladder or promontory bids fair to be difficult, or if the affected chain of glands extends high upward; or

2. If the growth is situated high up and there is serious doubt as to the possibility of removing it; or

2. If an operation is preferred on account of chronic obstruction and the tumor is situated so low down in the sigmoid flexure or rectum that intestinal suture is difficult or impossible.

After-treatment and Prognosis.—After the perineal operation the patient lies in bed on his back. After the sacral operation he should lie on the side, being rolled occasionally to the other side. Morphine is usually required. For a week only fluids should be given, together with a certain amount of opium to prevent action of the bowels. The outer dressing should be changed as soon as it becomes moist, but the iodoform gauze packing should not be disturbed until the eighth day, and not wholly removed for two or three days thereafter. Afterward the patient should be treated by sitz baths and evacuation of the bowels brought about by the administration of castor oil. During the first week infection of the wound with feces is shown by an increase of temperature and the other symptoms of abdominal sepsis. If this occurs, the packing should be removed and the wound irrigated once or twice daily. Sitz baths or a permanent water-bath are helpful. In about one-third of the cases catheterization will be required for two weeks or longer. The power of micturition almost always returns in time.

Mortality of the operation was formerly from 30 to 50 per cent. More than one-half of the deaths were due to infection either in the pelvis or less often in the peritoneal cavity. A small number of patients died from loss of blood, from the antiseptics or disinfectants used, and from other causes. Some writers have spoken of iodoform poisoning, but it is striking that Bergmann, Kraske, and Czerny have never experienced a bad result from iodoform gauze, although they have used it most systematically. Probably most of the so-called cases of iodoform poisoning were really some creeping form of infection due perhaps to Bacterium coli. A number of patients have died from complications, such as pleurisy, pneumonia, and embolism. Some recent statistics collected by Krönlein show a mortality of 19.4 per cent. in 881 cases, 51 per cent. of the deaths being due to infection of the wound and peritoneum, 20 per cent. to heart failure and collapse, 13 per cent. to pulmonary complications, and 15 per cent. to other causes. All of these patients were operated upon in Germany. In the statistics of individual operators there is a marked improvement in the results obtained during the past few years. Thus, Kraske's mortality up to the year 1890 was 34 per cent.; from that time until 1897 it was 9.8 per cent. Czerny's latest statistics show a mortality of 8 per cent., and Hochenegg's, 8.6 per cent.

Rave collected statistics of 335 cases of rectal carcinoma treated by operation in the clinics of Krönlein, Schede, Mikulicz, Garrè and

Albert. Sixty-seven patients died, giving an operative mortality of 20 per cent. These deaths were due, 38 per cent. to sepsis and peritonitis, 18 per cent. to collapse and heart failure, 19 per cent. to pulmonary complications, and 25 per cent. to other causes. In 17 per cent. of all the fatal cases there was found at autopsy gangrene of the bowel.

The mortality depends in large measure upon the seat of the tumor. The operative mortality was only 17 per cent. in 264 cases of tumor situated so low that the finger could be passed above its upper margin; whereas the mortality was 28 per cent. in 71 cases of tumors situated higher up.

The method of operation seems to have little effect upon the mortality. Thus 59 low-seated tumors were removed by the perineal method, with a mortality of 12 per cent.; 66 by Kocher's method (removal of the coccyx), with a mortality of 13 per cent.; and 85 by Kraske's method, with a mortality of 15 per cent. The higher tumors were almost all operated upon by Kraske's method, with a mortality of 23 per cent. Temporary resection of the sacrum gave a mortality of 45 and 27 per cent. for tumors situated respectively low down and high up in the rectum.

Sex has an important influence upon the mortality, which was in low-seated tumors operated upon perineally and by Kocher's method 15 and 20 per cent. in men, and 7 and 6 per cent. in women, respectively. Kraske's operation gave a mortality of 20 per cent. in women and 13 per cent. in men. This was in tumors seated low down. For high-seated tumors it gave a mortality of 33 per cent. in women and 19 per cent. in men. This higher mortality in women may be explained by the fact that the tumors easier of access were operated upon perineally in women.

The statistics show no great difference in mortality after amputation, and after resection and suture or invagination.

The Choice of Operation.—Formerly, when rectal carcinoma was operated upon only by perineal methods, the radical removal of the tumor was not attempted unless it was situated low down. With the introduction of Kraske's and other sacral methods the radical removal of high-placed tumors was made feasible. The high mortality which followed the sacral operations has led the most conservative surgeons to restrict this method of operating to those cases only which cannot be treated through a perineal incision. If the coccyx is removed, the pelvic rectum may be easily exposed, so that only tumors so high up as the pelvic colon require the sacral operation. Among surgeons who take this view may be mentioned Czerny, König, Küster, Wölffler, Eiselsberg, Rehn, and Senn; while Hochenegg, Albert, and Mikulicz still adhere to the sacral method for all tumors except those of the perineal rectum. As the statistics above given show, the mortality is higher for tumors higher placed, by whatever method they are removed. Only osteoplastic resection shows an abnormally high mortality.

In men the perineal operation is suited only to the removal of tumors at or just above the anus. In such a tumor whose upper border can be easily reached with the finger, it is still necessary to resect the coccyx in order to remove the affected glands behind the pelvic rectum. Tumors of the pelvic rectum may sometimes be removed by Kocher's method, but it is better to remove them and tumors of the pelvic colon through a sacral incision.

Carcinoma of the pelvic colon which is attached to the base of the bladder or to the promontory, or to coils of small intestine, and carcinoma of the sigmoid colon, are best treated through an abdominal incision, combined perhaps with either a sacral or a perineal incision.

In women the case is somewhat different. The width of the pelvis and the presence of the vagina make it possible to remove even tumors of the pelvic rectum either through the vagina or through a para-anal or a parasacral incision, or through a combination of these, thus avoiding the sacral incision, which in women has so high a mortality. Tumors of the upper pelvic colon and of the sigmoid colon are most accessible through an abdominal incision to which a vaginal incision may often be added with advantage.

Functional Results. — Amputation of the rectum leaves the patient with a permanent perineal or sacral anus. If the bowel sloughs or retracts during the healing, cicatricial stenosis results. If this cannot be overcome by treatment with bougies, a second operation is necessary in order to free the bowel and to stitch it again to the skin ; or the skin may be loosened and extended upward until it can be united to the bowel by suture.

In rare cases the artificial anus dilates and prolapse of the rectal mucous membrane occurs.

A patient with an artificial anus of this character is unable to retain either gas or fluids, but can usually retain solid fecal matter ; hence if he pays strict attention to his diet and takes an enema every morning, or every other morning, he can ordinarily avoid soiling his clothing. An enema is more satisfactory than a laxative since the latter may produce semifluid stools for several hours. In some cases the sensitiveness of the mucous membrane becomes such in three or four months that the patient can foretell his movements by a few minutes.

The most satisfactory bandage for a perineal anus is a simple T bandage, or swimming trunks with a pad of cotton and gauze. For a sacral anus the apparatus designed by Hochenegg is most satisfactory. It presses the bowel against the edge of the sacrum by means of the rubber pad and a spring which is fastened to a girdle about the pelvis. Or the patient may simply wear a sponge held in place by a rubber bandage.

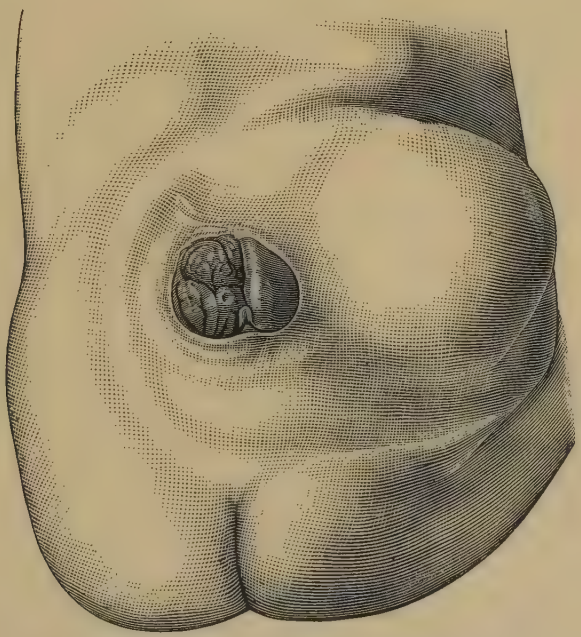
Most patients with an artificial anus are able to attend to their business without difficulty.

Gersuny's plan to give continence by twisting the lower end of

the bowel, has not fulfilled the expectations of its followers. Prutz found that only 2 of 28 patients so treated had permanent continence, and any method may give an occasional relative continence.

The functional results after resection of the rectum are naturally far better than after amputation of the rectum. One of the mishaps which sometimes follow is rupture of the circular suture. If the gap is a small one, the resulting fistula will heal spontaneously in a few weeks. If the gap is a large one and situated, as is usually the case, posteriorly, an artificial anus will result and the most of the fecal matter will pass through the wound. If gangrene of the whole circumference of the intestine takes place, or the cut ends of the bowel

FIG. 53.



Traumatic sacral hernia following resection of sacrum for carcinoma of the rectum. (Tietze.)

separate on account of too great tension, there will be a defect extending clear across the bowel. If only the posterior part is affected, the mucous membrane of the anterior part has a tendency to work out of the wound, making a sort of spur. This must be overcome by the regular passage of bougies and a constant strapping together of the soft parts of either side of the wound. If these simple measures fail, a second operation is necessary to overcome the spur-formation, to loosen and suture the mucous membrane that has separated posteriorly, and, finally, to close the skin over the wound. Wolff has made use of flaps from the gluteal region to close a defect in the

rectum, turning their skin surface inward. In most instances in which the ends of the bowel can be sutured without undue tension either a permanent cure will result or the fistula which remains will be insignificant.

The condition which exists after invagination of the bowel is far better. The commonest complication of this operation is gangrene of the inner portion which may necessitate a subsequent plastic operation.

Czerny was able to preserve sphincteric action 15 times in 40 cases. In 7 of these cases Kraske's operation was followed by complete continence. Föderl says that 72 per cent. of the patients who recover from resection and invagination of the bowel have full continence.

The final results are known in 53 patients who recovered from operations performed by Hochenegg. Continence was obtained after invagination 24 times, after primary suture 5 times, and after suture with a fistula 5 times. In the remaining cases there was a permanent sacral anus. In 1902 he described the condition of 30 patients who have lived more than three years after operation: 10 had full control of their movements, 2 partial control, while 14 had a sacral anus and 3 a perineal anus. Kraske, Schede, and Wölffler have obtained complete continence in almost one-half of the patients who survived operation.

Late Results of Radical Operations.—It is generally admitted that three years must elapse after a radical operation for cancer before a patient is considered cured. Recurrence, it is true, may occur at a still later period, but it is rare. Krönlein found that of a total of 640 patients operated upon for carcinoma of the rectum, 95, or 14.8 per cent., were free from recurrence for three years or more. This figure should be increased somewhat, since in the 640 cases were included 19 per cent. of fatal cases, and there were besides a number of patients who were free from recurrence although they had not reached the three year limit. (See recent literature for other statistics.)

Statistics of Czerny, Bergmann, König, and Kraske show that about 20 to 30 per cent. of patients who survive the radical operation pass the three-year limit without recurrence. Rotter's percentage is 33, and Kocher's is 50, when the percentage is based only on those cases in which operation was performed more than three years previously. Hochenegg had 84 patients in this class, and 21 of them showed no sign of recurrence after an interval of three years or more. This gives a percentage of cures of not less than 25 per cent.; or, dividing the number of cures by the total number of operations (121), the cures are equal to 14 per cent. of all patients operated upon. In 1902 he reported 174 patients operated upon, with 17 per cent. of patients cured for three years or more.

It is probable that about one-fourth or one-fifth of the patients oper-

ated upon for cancer of the rectum can be permanently freed from their disease. This statement is based on statistics of operations performed upon tumors some of which were no longer at an early stage of growth. Better results may be expected not only when patients are operated upon at an earlier date, but when surgeons are more particular to remove affected lymph-glands as well as the affected portion of the bowel. Statistics further show that the younger the patient the more likely recurrence is to follow operation; hence some surgeons do not consider operation justifiable upon patients under forty years of age.

Treatment of Inoperable Cancer of the Rectum.—Several operations have been advocated to relieve the serious symptoms which result from stenosis of the rectum and the necrosis of the new growth.

1. Curettage of the tumor is of assistance in removing the gangrenous masses of tissue and preventing stenosis. The hemorrhage is sometimes so tremendous, and is so poorly borne by the enfeebled patient, that this procedure is not often carried out. An additional risk in case the tumor is situated high up is perforation of the peritoneal cavity with rapidly fatal peritonitis.

2. Local proctotomy is seldom performed, and is at best suited only to fibrous cases.

3. Iliac colostomy is the operation everywhere advocated. The risk of opening the peritoneal cavity is now so slight that this operation is much to be preferred to the more difficult lumbar colostomy outside the peritoneal cavity.

Iliac colostomy, by allowing all of the fecal matter to escape through an opening in the sigmoid flexure, relieves at once the symptoms of iliac obstruction and lessens to a marked degree the gangrene and hemorrhage in the rectum by freeing the new growth from contact with fecal masses. It has sometimes been stated that colostomy exercises a good effect upon the tumor, so that an incurable case may become operable. This conclusion is due to careless observation. The apparent improvement is wholly due to subsidence of accompanying inflammation.

Colostomy has generally a favorable influence upon the condition of the patient. The chronic sepsis due to fecal obstruction, and the hemorrhage and gangrenous discharge grow less, and the patient is freed from the annoying tenesmus. There will still remain the stricture due to the resulting new growth and the pains which are due to its progress. These may be slight or very severe. Some persons improve so much with the return of appetite and ability to sleep, that they gain in weight and strength and are frequently able to resume their occupation. For these reasons a colostomy will often prolong life very materially. It is an operation without much danger which can frequently be performed with a local anæsthetic. Czerny performed the operation 43 times with 3 deaths, the remaining 40 patients living from forty days to three and a half years, 12 of them living more than fifteen months.

The disadvantages of an iliac anus are differently estimated by different surgeons. It is fair to state that they are not so great as one might theoretically suppose them to be. If the patient pays strict attention to his diet and moves the bowels every morning by thorough irrigation, he usually has no trouble for the rest of the day. When one compares this condition with that of a patient suffering from stenosis and gangrene of the rectum one readily understands that most patients will find little fault with the iliac anus.

The indications for colostomy vary in the minds of different surgeons according to their views of the disadvantages of an iliac anus. Kraske, for example, does not advise colostomy unless obstruction is present or is threatening. Czerny, König, and Rotter believe that a colostomy should be performed whenever there is frequent and annoying discharge of mucus and gangrenous material, or whenever enemas and irrigations fail to give satisfactory movements of the bowels. The directions for establishing an artificial anus are given in Vol. IV., page 461.

ABNORMALITIES, INJURIES, AND DISEASES OF THE KIDNEY AND URETER.

By Prof. SCHEDE.

CHAPTER IX.

EXAMINATION OF THE KIDNEY AND URETER.

Anatomical Characteristics and Relations.—It is to be assumed that every surgeon is familiar with the anatomy of the kidney and the neighboring organs. Certain points of especial surgical interest will, however, be brought forward. These points are chiefly connected with the coverings of the kidney, with its nerves and vessels, and the topographical relations of the kidney and ureter to the neighboring organs.

The parenchyma of the kidney is firmly surrounded by a thin, transparent, but strong fibrous capsule. Numerous connective-tissue septa spring from the capsule and pass into the parenchyma, but they are of such delicate structure that they do not perceptibly interfere with the peeling off of the capsule from the kidney. In certain pathological conditions their strength is increased so that the capsule cannot readily be peeled off. In the fœtus stronger bands separate the lobules of which the organ is composed.

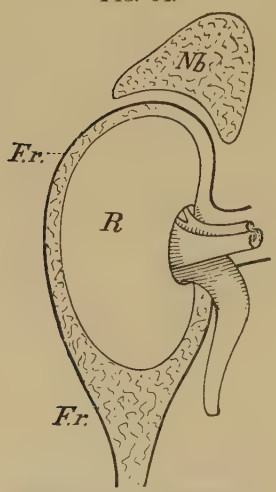
From the median border of the parenchyma the capsule extends to the hilus covering the outer wall of the papillæ and the calices of the pelvis. A thin prolongation covers the nerves and vessels which enter and leave the hilus and accompanies them to the aorta and vena cava. A much firmer layer passes behind the vessels between them and the ureter, and joins partly with the sheath of the aorta and partly with the fascia which covers the lumbar portion of the diaphragm. This prolongation, according to Englisch, acts as a suspensory ligament of the kidney, and is of considerable importance in maintaining the position of this organ.

The kidney is surrounded by an outer capsule of fat which is connected with the fibrous or inner capsule by numerous delicate bands of connective tissue. This fatty capsule protects the kidney from the effects of blows and other external injuries. The capsule is thickest over the convex border at the hilus, at the lower extremity, and on the posterior surface. This fat is not found in the newborn, and is very scanty even in children of ten years. In adult life it disappears rapidly during emaciation.

Sappey and Zuckerkandl describe a fairly firm thickening of the connective tissue on the posterior surface of the fat-capsule of the kidney, which they call the fascia retrorenalis. On the anterior surface also is a more or less developed fascial layer which Gerota has called the fascia prerenalis. This is more marked on the left side of the body, where it is intimately associated with the retroperitoneal connective tissue of the descending mesocolon, passing from there over the anterior surface of the kidney up to the pancreas, and over this until it reaches the front of the vessels lying on the vertebral column. This fascia is found on the right side with difficulty or not at all, except in those cases in which the ascending colon entirely covers the whole of the kidney.

These fasciæ join along the convex border of the kidney and above the upper pole. On the inner margin of the kidney they are separated, since the retrorenal layer is lost in the periosteum of the vertebral column and the prerenal layer passes over the abdominal vessels to be continued on the other side of the body. These layers are also separated at the lower pole. Hence the fat of the fatty capsule is continuous with that in the iliac fossa.

Fig. 54.



Renal fascia; *R*, kidney; *Nb*, suprarenal body; *Fr*, fascia renalis. (Gerota.)

These two layers of fascia really form a third capsule of the kidney, which may be called the fascia renalis in contradistinction to the capsula adiposa and tunica propria. (Fig. 54.) Anteriorly this fascia lies close to the peritoneum. Posteriorly it is connected with the sheaths of the psoas and quadratus lumborum muscles by connective-tissue septa. These septa also pass between the bundles of muscle-fibres, and some of them reach the periosteum of the vertebra. At the inner margin of these muscles the union between the fascia renalis and the muscular sheaths is especially firm. And this is the chief point of attachment to hold the kidney in place.

Outside of the renal fascia there is a loose supraperitoneal connective tissue which often contains a certain amount of fat, and which has been called by some the supraperitoneal fascia, and by others the perirenal fat.

From this description it appears that the fastenings of the kidney are not so strong as they might be, and that they may be overcome by moderate force. Aside from the prolongations of the fibrous capsule and the attachments of the renal fascia described above, there is little to hold the kidney in place excepting its own vessels. These vessels, it is true, are very large in proportion to the size of the organ, and are not very movable. Whether there are other causes which retain the

kidney in its normal position is more fully discussed in the section devoted to Movable Kidney.

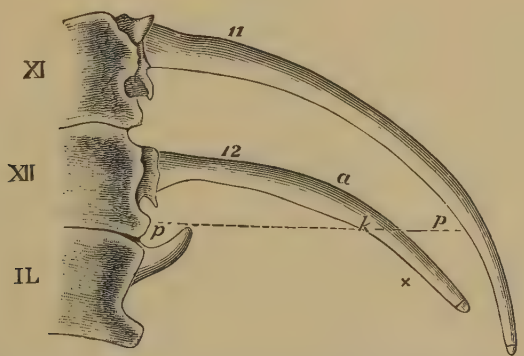
The kidneys lie in the lumbar regions on either side of the vertebral column. Each kidney occupies the upper third of the lumbar fossa, a

FIG. 55.

Transverse section through the region of the left kidney: 1, external oblique muscle; 2, internal oblique muscle; 3, transverse muscle; 4, transverse fascia dividing at 5 into a deep layer, 6, and a superficial layer, 7; 8, sacrolumbar muscle; 9, quadratus lumborum muscle; 10, psoas muscle; 11, descending colon; 12, pancreas; 13, kidney: 14, spleen; x, direction of Simon's incision along the border of the sacrolumbar muscle. (Esmarch and Lange.)

space which is bounded behind by the muscles of the back and loin, in front by the peritoneum, below by the ilium, and above by the diaphragm. A kidney normally extends from the upper margin of the

FIG. 56.



Showing the relations of the pleura and the eleventh and twelfth ribs. The reflection of the pleura is represented by the dotted line *pp*. This line is practically the same whether the twelfth rib is present or not: so that if the rib is absent, or reaches only to the point *a*, the pleural cavity is more likely to be injured by wounds or at operations.

twelfth rib to the lower margin of the second lumbar vertebra, or sometimes to the middle of the third lumbar vertebra—a distance which corresponds to the space between the spinous process of the

eleventh dorsal vertebra and the spinous process of the second lumbar vertebra. On account of the presence of the liver, the right kidney is usually situated a finger's breadth lower than the left.

The kidney is usually placed to the side of the transverse process, but it may approach nearer to the bodies of the vertebra. It may then be rotated a little around its long axis so that the posterior surface of the kidney lies against the spinal column, while the hilus is directed almost forward, and the anterior surface of the kidney is turned outward.

The posterior surface of the kidney lies partly upon the quadratus lumborum muscle and partly upon the transversalis abdominis muscle. It is therefore covered by the thinnest part of the posterior abdominal wall. It lies on the border of the sacrolumbalis muscle, and further back it is covered by the latissimus dorsi, the lumbodorsal fascia, and the transversalis abdominis muscle. (Fig. 55.)

The upper portion of the kidney lies very close to the pleural cavity, and this is more true of the left kidney than it is of the right. The exact knowledge of this relation is of great value to the operator.

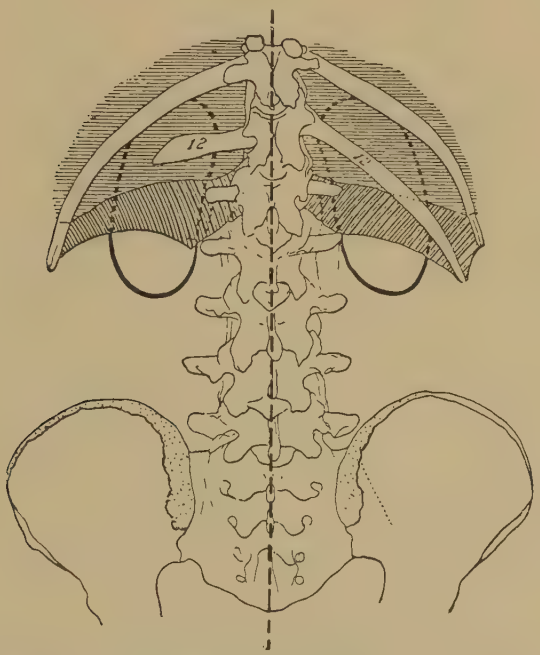
If the twelfth rib is normal, the reflection of the pleura is about in the line p. k. P′ (Fig. 56), extending from the lower margin of the body of the twelfth dorsal vertebra and reaching the eleventh rib 3 or 4 cm. (1.2 or 1.6 inches) behind its costal cartilage. Luschka puts this point 4.5 cm. (1.8 inches) from the tip of the cartilage of the eleventh rib; and the point k, where the line crosses the twelfth rib, at 4 cm. (1.6 inches) from its tip. According to Récamier, the reflection of the pleura near the spinal column is 1–1.5 cm. (0.4 to 0.6 inch) below the twelfth rib, passing obliquely outward and downward until it crosses the twelfth rib, if the rib is long enough, and then crosses the eleventh intercostal space, still proceeding obliquely downward until it reaches the eleventh rib some 10 or 12 cm. (4 or 4.8 inches) from the median line. (Fig. 57.) The lowest point of the pleural cavity is where it is reflected on the eleventh rib. The tip of the twelfth rib lies over the sacrolumbar muscle and is not covered by the pleura.

In the removal of the kidney the surgeon cuts close to the twelfth rib, and may find it necessary to excise this rib, hence exact knowledge of these relations is of great importance to him. This knowledge is doubly necessary because the twelfth rib varies so considerably in its development. It may be so short that it cannot be felt, or it may be entirely wanting. If it is wanting on both sides, the twelfth dorsal vertebra is usually absent. Holl examined 120 subjects, and found an absence of the twelfth rib 6 times, the absence in 3 of these instances being double; while 20 times (counting the sides individually) the twelfth rib was so short that it could neither be felt nor seen from without. On account of this variation Paoli advises that the ribs should be counted from above downward. An equally certain method, and one which is more easily and quickly carried out,

is to feel for the free ends of the lower two ribs; if they can both be felt, the twelfth rib is certainly present. (Küster.)

The kidneys lie behind the peritoneum, which covers their anterior surface, but to a different extent on the right and left sides. On the right side the peritoneum passes from the liver to the anterior surface of the kidney, which it covers only so far as the liver extends. The lower third of the kidney, is not covered by peritoneum. The peritoneal covering of the left kidney is derived in part from the general

FIG. 57.



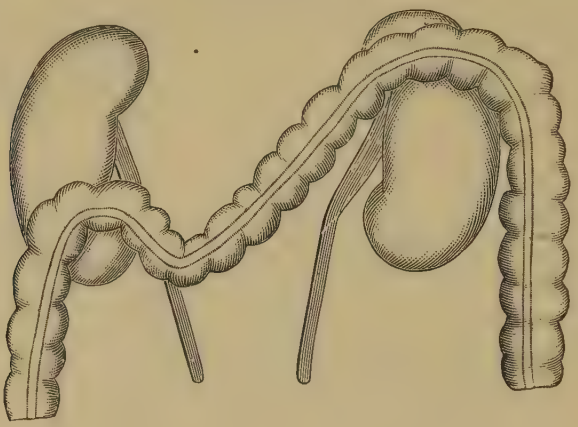
Showing the position of the pleura when the twelfth rib is long (right side) or short (left side). (Récamier.)

peritoneal cavity and in part from the omental bursa. The total portion of the left kidney covered with peritoneum is far less than that of the right kidney. On account of the different relations of the abdominal organs to the right and left kidneys, it is better to study each kidney separately.

The upper two-thirds of the anterior surface of the right kidney is covered by the under surface of the liver. The lower third of the kidney is covered by the right or hepatic flexure of the colon. The kidney's inner border touches the vertical portion of the duodenum, to which it is united by a strong covering of peritoneum which holds the duodenum in close relation to the vertical column. Perinephritic abscesses, if they break through into the intestine, empty themselves

either into the duodenum or into the colon. The suprarenal gland is wedged in between the liver and the kidney.

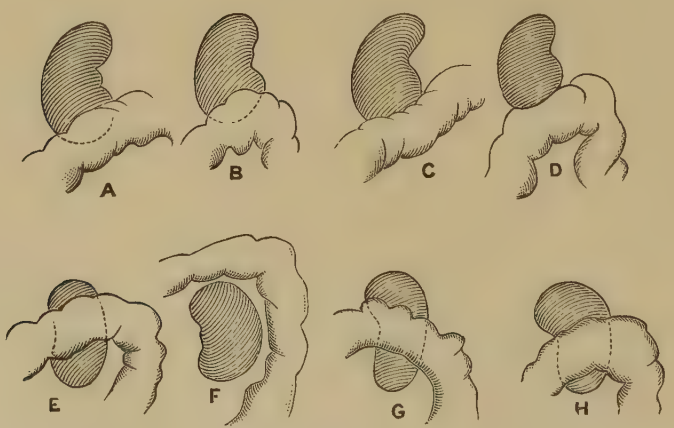
FIG. 58.



Relations of the colon and kidneys. (Guillet.)

The colon crosses the lower pole of the kidney in a curve, concave downward (Fig. 58), but its relation is a variable one, as is shown by Fig. 59.

FIG. 59.



Showing the usual relative positions of the colon and kidneys: A, B, C, D, right kidney; E, F, G, H, left kidney. (Helm.)

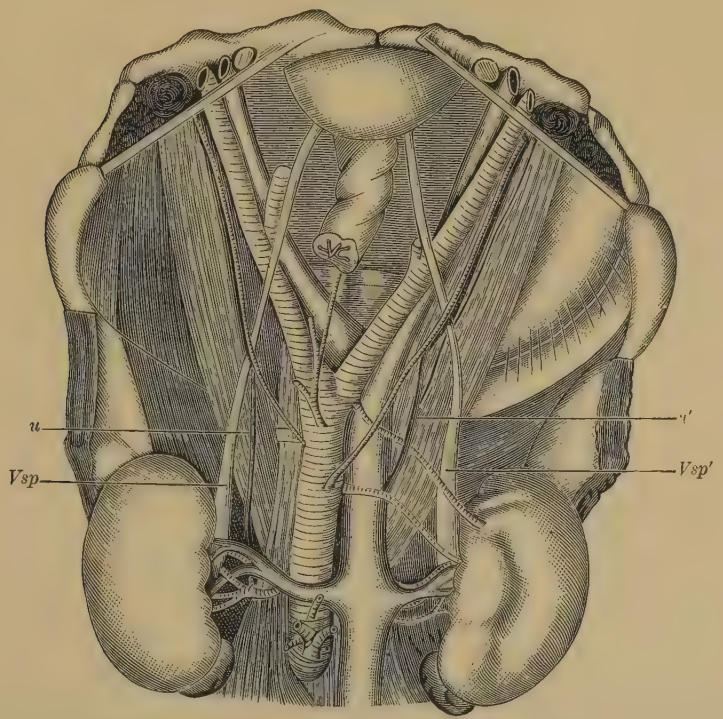
The upper third of the anterior surface of the left kidney is directed toward the stomach, while the middle third of its surface is directed toward the pancreas, and the lower third is covered by the posterior layer of the peritoneum. The suprarenal lies above the hilus on the

inner border of the kidney. The outer border is above in contact with the spleen; below it is bounded by the descending colon.

The posterior surface of the ascending colon and of the descending colon as well is not covered by peritoneum, and hence the intestinal wall is in direct contact with the fatty capsule. Only in rare cases does the peritoneum entirely surround the colon at these points, thus forming a mesocolon.

The ureter (Fig. 60) extends retroperitoneally downward and inward to the pelvis until it reaches the posterior wall of the bladder, whose muscular and mucous coats it perforates obliquely. In the

FIG. 60.



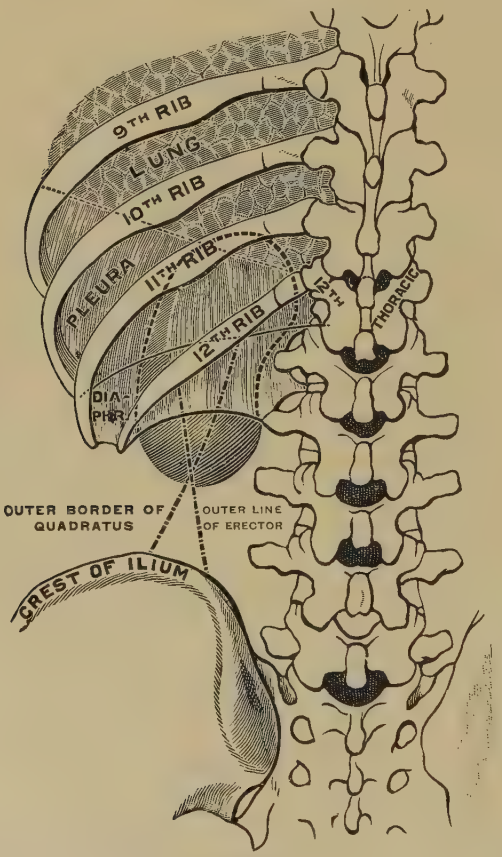
Dissection of the posterior abdominal wall: *u*, *u'*, right and left ureters; *Vsp*, *Vsp'*, right and left spermatic veins. (Gerlach.)

beginning of its course it lies upon the psoas muscle. Just below the middle of the psoas the ureter passes behind the spermatic artery crossing it at an acute angle. A little further down it crosses in front of the common iliac artery just above its division into the external and internal iliac. Sometimes it crosses the external iliac below its origin in the common iliac. The right ureter is covered by the ileum, the left by the sigmoid flexure.

The lumen of the ureter varies. Fusiform dilatations alternate with narrower portions, as may be readily seen by injecting the vessel

with some substance which becomes rigid. The ureters are extremely distensible, and may be much dilated by the passage of calculi, or by obstruction to the flow of urine. If such obstruction is long continued or frequently repeated, the ureter may be dilated until its lumen is nearly that of the small intestine.

FIG. 61.



Showing relation of the left kidney to the lung, pleura, ribs, spine, muscles, and hip-bone. (Testut.)

The course of the ureters can be determined in the living subject as follows:

1. The point where the pelvis of the kidney terminates and the ureter begins may be obtained from two lines. One of these is a horizontal line at the level of the last rib, the second is a vertical line parallel to the median line of the body and crossing Poupart's ligament one-third of the distance from the spine of the pubes to the anterior superior spine of the ileum. The beginning of the ureter is 6 cm. (2.4 inches) below the point where these two lines cross. (Fourneur.)

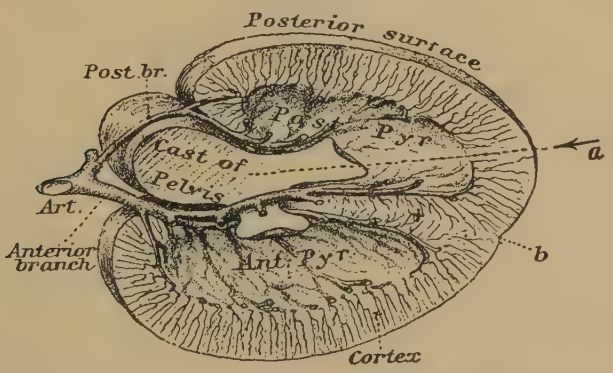
2. The next point to be determined is the middle of the portion of the ureter which lies above the pelvis. This is exactly at the level of a horizontal line drawn half-way between the tip of the ensiform cartilage, and the upper margin of the symphysis pubis. The ureter crosses this horizontal line from 3 to 4 cm. (1.2-1.6 inches) from the median line, according to the size of the individual.

3. The point of entrance of the ureter into the pelvis may be determined as follows: A line is drawn connectiug the anterior superior spines of the ilia and is divided into three equal parts. The points of division will lie over the right and left ureters respectively. In order to feel the ureters it may be necessary to palpate a finger's breadth above this horizontal line in order not to press the finger-tips below the pelvic margin.

In certain cases the position of the ureters may be shown in a radiograph after metallic catheters have been passed into them.

The chief vessel of the kidney, and the only one which enables it to perform its functions, is the renal artery. This vessel, whose diameter (6 cm.; 2.4 inches) is quite out of proportion to the size of the organ, springs at right angles from the abdominal aorta and usually divides into four branches before it enters the hilus of the kidney. Two of these branches enter the anterior portion of the organ, and two of them the posterior portion. The posterior surface of the pelvis is free from large vessels. This is the usual distribution. Jössel

FIG. 62.

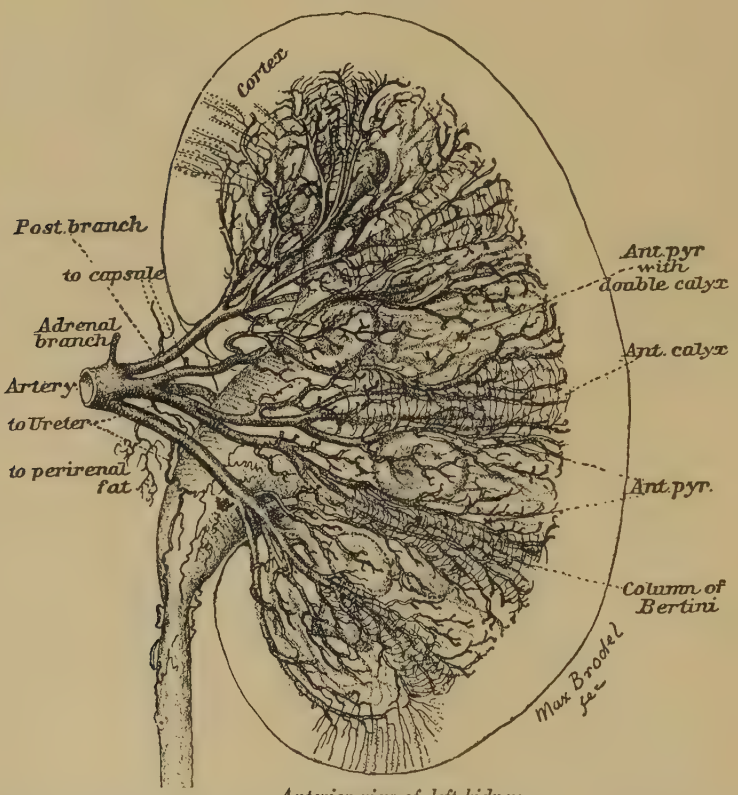


Showing the renal artery and the distribution of its branches in relation to the pelvis of the kidney. The dotted line *a* indicates the plane of arterial division; *b*, shows the depression on the surface which marks the border-line between the cortical portions of the anterior and posterior row of pyramids. This figure is drawn from a corrosion specimen. (Kelly.)

describes the renal artery as dividing into two anterior, one superior, and one posterior branch. One of the two anterior branches goes to the middle of the organ and the other to the lower portion. The upper branch is distributed to the upper end of the kidney. The posterior branch is distributed to the lower two-thirds of the posterior surface of the kidney. (Figs. 62 and 63.) The arrangement of the

arteries is frequently different from that described as normal. Zondek examined 15 kidneys, and found that 9 of them were supplied by one renal artery, 5 by two, and 1 by three arteries. Instead of two anterior and two posterior branches, he sometimes found two anterior branches and only one posterior branch ; or, an inferior branch for the lower pole, a middle branch for the middle part of the anterior surface, and an

FIG. 63.



Anterior view of left kidney.

Transverse section through middle of left kidney. The anterior branches of the artery are shown to supply about three-fourths of the kidney substance, while the posterior branch supplies only about one-quarter. (Kelly.)

upper branch for all the rest of the kidney. Usually the renal artery or its branches enter the hilus of the kidney ; but in many instances a separate artery enters directly into one or the other pole. This fact explains why in removal of the kidney hemorrhage is so often noticed in spite of ligation of all the vessels which enter the hilus. The right renal artery is about 1.55 cm. (0.6 inch) longer than the left on account of the situation of the aorta on the left side of the median line. Zondek says that the total area of the cross-section of the anterior branches is greater than that of the posterior.

The arteries of the fatty capsules of the kidney vary in size from that of a sewing-needle to that of a knitting-needle. They spring from the renal artery or its branches, from which they may pass directly into the capsule, or they may reach the capsule after having penetrated the renal parenchyma. The fatty capsule also receives a branch from the first lumbar artery which springs from the aorta above the renal artery. This vessel may give rise to considerable hemorrhage when torn by a blunt dissection to expose the kidney. According to Litten, the spermatic arteries also send branches to the kidneys.

An important and interesting peculiarity of the chief branches of the renal artery is the fact that the territories in the kidneys to which they are distributed are perfectly distinct. This can be shown very nicely in corrosion preparations. The vessels with their branches may sometimes be separated without injury to even the finest terminal branches. This separation is most marked between the anterior and posterior sections of the kidney. Hyrtl called attention to this fact as long ago as 1870. The boundary-line between these arterial systems does not usually correspond with the median line (the line of incision at autopsy), but is from 0.5 to 07 cm. (0.2-0.3 inch) behind it. The territory of the posterior branches is therefore less than that of the more prominent anterior branches. In rare instances, as Kümmel points out, the line between the two arterial systems corresponds with the middle line.

On account of this peculiarity one may split open the middle third of the kidney clear into the pelvis without giving rise to much hemorrhage. As the incision approaches the poles there is risk of cutting a large branch and thus producing the local death of a considerable section of the kidney; for, as already stated, the branches are terminal branches and have no mutual anastomoses.

This anatomical fact also explains many pathological conditions found in the kidney, such as the occurrence in one pole of a sharply limited tuberculosis, or the relation between perinephritic abscess and affections of the kidney, hemorrhage in nephrotomy, etc. It shows also where the incision should be made in the kidney in order to avoid wounding the important vessels, and also in what manner resection should be performed in order to avoid hemorrhage, and to avoid interference with the blood-supply of the portions of the kidney which are not excised.

The renal veins emerge from the hilus behind the arterial branches of the anterior surface of the kidney. They join in a common trunk which passes behind the renal artery to the vena cava.

The lymph-vessels are superficial and deep; the latter to the number of four or five, emerge from the hilus, accompany the large vessels toward the median line, and terminate in the lumbar glands. The superficial vessels are more slender and empty into the deeper ones.

The nerves of the kidney form a network about it called the renal plexus. This is made up of branches from (1) splanchnic nerves from

the thoracic portion of the sympathetic; (2) the lumbar portion of the sympathetic; (3) the spermatic plexus; (4) the aortic plexus; (5) the vagus; (6) the major splanchnic; (7) and chiefly, the cœliac plexus. Through the cœliac plexus the renal plexus also receives fibres from both splanchnics, from the phrenic, from the vagi—especially the right—and the aortic plexus. The fibres of the renal plexus are for the most part vasomotors, both dilators and constrictors. There are also a few sensory fibres. It is undetermined whether the plexus contains trophic nerves or true nerves of secretion. (Sehrwald.)

The centre for the vasomotor nerves of the kidney lies in the bottom of the fourth ventricle. Irritation of this portion of the brain produces a vascular contraction and diminution of secretion. Paralysis of this portion (injury) produces vascular dilatation and polyuria. If at the same time the centre for the vasomotors of the liver, which lies close by, is paralyzed, mellituria as well as polyuria will be produced. Masius concluded from his experiments upon animals that the nerve-fibres which constrict the vessels of the kidney run partly in the cervical vagus and partly in the splanchnic, and that by irritation of these nerves secretion of urine can be produced. He was able to suspend the effect of such irritation by giving large doses of chloral, which paralyzed the vasoconstrictors. This explains the remarkable phenomenon of reflex anuria—the complete suspension of all urinary secretion which sometimes follows an injury or an operation upon one kidney, or obstruction caused by a stone in one ureter. An irritation acting upon the sensory nerves of one kidney or one ureter can, in a reflex manner, stimulate the vasoconstrictors of both kidneys to such a degree that both organs become anæmic and cease to secrete urine. If this condition continues for a considerable time, recovery will be impossible, since the epithelium will have been destroyed.

Methods of Investigation.—Direct examination of the kidney by inspection and palpation is much interfered with by the position of the organ, hidden as it is beneath the ribs and abdominal viscera. Nevertheless, a surgeon whose touch and sight are practised, and who is familiar with the various methods of diagnosis, will often be able to obtain information as to the condition of the kidney which is quite out of reach of one who has not had experience in this kind of diagnosis.

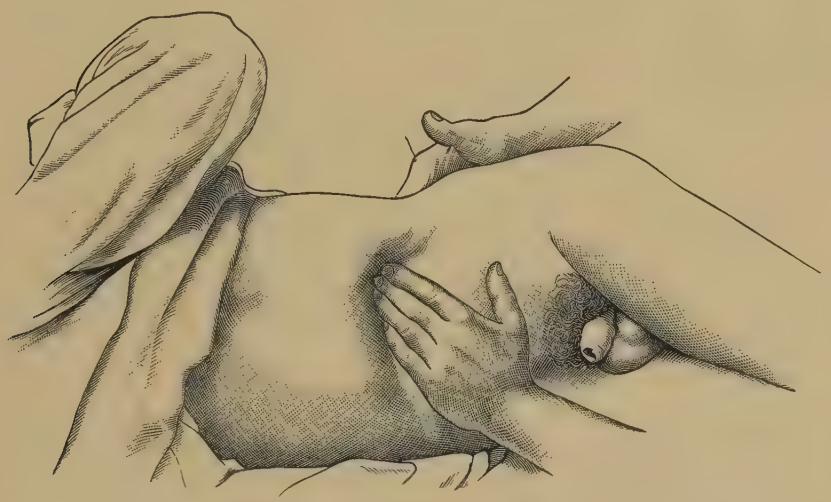
In all surgical diseases careful inspection of the region of the body in which the disease has its seat should precede every other method of examination. In the case of the kidney there may be a noticeable swelling due to suppuration or retention of urine, or to a new growth; or, there may be ecchymosis, the result of traumatism; or, in very thin persons, the kidney itself may give shape to the overlying tissues. The anterior surface of the abdomen should be inspected as well as the back. Slight differences on the two sides of the body are more likely to be noticed by looking along the surface from above rather than by looking directly at the surface from the side.

Palpation is far more valuable in the matter of diagnosis than

inspection. Bimanual palpation may be carried out in a number of ways. For example, in a posture midway between sitting upright and lying on the back, or with the patient lying on the side (Fig. 64), or standing up, or inclined forward. The position first mentioned is the best for the majority of cases, since it facilitates palpation of most of the surface of the kidney. This is carried out as follows:

The patient may be in bed or on a couch, in a position midway between dorsal decubitus and an upright position. It is essential that the head should be well supported in order that the abdominal muscles

FIG. 64.



Palpation of the kidney, with patient on the side. (Hartmann.)

may be completely relaxed. In this position both kidneys sink as low down as their attachments permit, and hence they are in the most favorable situation for examination. (Fig. 65.) In order to palpate the left kidney the surgeon stands on the left side of the patient, and to palpate the right kidney he stands on the right side of the patient. As he stands facing the patient, if he is examining the right kidney, he places the left hand under the twelfth rib just in front of the lumbar muscles. The right hand is placed on the front of the abdomen and an attempt is made to feel the kidney between the two hands. In order to palpate the left kidney the surgeon stands on the left side of the patient, and places his left hand on the front of the abdomen and the right hand on the lumbar region. By this method of palpation the surgeon will at once feel kidneys which are displaced downward, movable kidneys, and kidneys that are much enlarged. If the kidney is not at once felt, the fingers of the hand lying on the abdomen should be carefully passed under the margin of the ribs, while the patient is encouraged to relax to the utmost the abdominal muscles and to

two hands can grasp the kidney between them and feel it slip upward, such a kidney is not to be considered a normal one, but is a movable kidney of the first degree. This is also the opinion of Küster; but there are others, among them Litten, who claim that in 6 to 8 per cent. of normal men, and in 30 to 80 per cent. of normal women, the kidney may be palpated. The smaller figures indicate the percentage for the left kidney and the larger that for the right.

All must agree, however, that in a certain percentage of women and in a large percentage of men it is impossible to palpate the normal kidney by any method of examination. Hence the failure to do so must never be considered an indication of a pathological change in the kidney.

The more movable the kidney is, the more of its surface can be reached by the palpating fingers, so that a kidney which is "floating" in a well-marked degree can often be grasped between the fingers, moved about by them, replaced in its normal situation, and again be allowed to come downward.

If a kidney is enlarged to any considerable extent, it can always be palpated, since its lower pole must reach further down than normally. If the fingers are able to touch the anterior and posterior surfaces, one can determine the thickness of the kidney and form a good estimate of how much it has increased in size. If the kidney is very much enlarged, as it may be in pyonephritis, tuberculosis, or new growth, it cannot be accommodated in its normal situation, but will extend far below, so that a considerable part of it will lie below the margin of the ribs. This portion is easily palpable. Such a kidney is not movable unless it possessed an abnormal range of motion before the pathological change developed which increased its size. On the contrary, the swollen kidney is apt to be intimately adherent to its surroundings so that it cannot be moved at all, and this is the case when the swelling is due to an inflammation, or to retention, or to a new growth.

It is not always easy to determine whether a tumor in the lumbar region really belongs to the kidney or whether it is attached to the liver, or is possibly a constricted lobe of the liver. The answer to this and similar questions can perhaps be given only after repeated examination, or, indeed, after an exploratory incision has been made.

It is of the greatest importance to establish the relation of the colon to the tumor in question. The splenic flexure of the colon crosses over the upper or lower pole, or in front of the middle of the left kidney. (See Fig. 60, E, F, G, H.) Hence a tumor arising from the left kidney must lie behind the colon. If the colon be distended by air blown into the rectum, its relation to the tumor will at once become manifest. A similar test if made with reference to the right kidney is less valuable. It was previously the opinion of writers that the ascending colon passed obliquely in front of the right kidney, so that a tumor of the right kidney must lie behind the ascending colon. The fallibility of this

test has been more than once demonstrated, and the explanation for this appears in the fact that the assumed relation of the colon to the kidney is by no means invariable. Indeed, in the majority of cases the colon only crosses over the lower pole of the right kidney, or scarcely passes in front of the kidney at all. (See Fig. 60, A, B, C, D.) Hence it is no wonder that the distention of intestine is of little value in the differential diagnosis between a tumor of the right kidney and one of the right lobe of the liver.

Schede reports a case of constricted lobe of the liver, movable kidney, and distended gall-bladder existing in one individual. When the colon was blown up with air, it lay below the mass, which was made up of gall-bladder, liver, and kidney. The condition was not evident until an abdominal incision was made. The kidney was then sutured through a posterior incision and the distention of the gall-bladder received its proper treatment.

On the left side a differential diagnosis between tumors of the kidney and those of the spleen may be equally difficult. It is worth remembering that the liver usually possesses a sharp border, while the notch in the middle of the edge of the spleen is often a help in diagnosis.

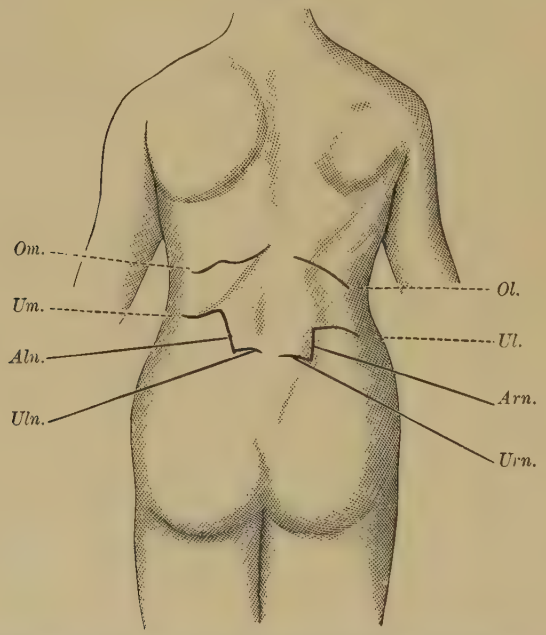
Bimanual palpation is often sufficient to establish a thoroughly accurate diagnosis. Thus, if one feels an especially hard nodule corresponding to the pelvis of the kidney, it is probably a calculus. If several calculi are present, they may sometimes be felt to grate upon one another, and this will, of course, absolutely fix the diagnosis. If the kidney is enlarged, and if its surface is irregular and rough and of firm consistence, a malignant tumor is probably present. If it is large and has a smooth, rounded surface, there may be an adenoma or uronephrosis, or pyonephrosis, or an echinococcus cyst. Fluctuation will indicate either a collection of fluid or a very soft tumor. It is to be remembered, however, that it is difficult to get fluctuation in a tumor that is sufficiently distended, and this is especially true of echinococcus cysts, which are so hard that they are frequently mistaken for solid tumors. If the kidney is enlarged but retains its normal shape, while its surface is smooth or slightly bulging, the diagnosis may lie between renal calculus, pyonephrosis, or tuberculosis.

Some years ago Simon proposed to introduce the hand into the rectum and into the intestine for the purpose of making more direct examination of the abdominal organs. This method of examination has been practically given up both because the hand is so compressed by the intestinal wall that it is much hampered in palpation, and also because of the paralysis of the sphincter or even rupture of the rectum which has occasionally been produced by the introduction of the whole hand.

Attempts have been made at different times to determine changes in the position of the kidney, as well as in its shape and size, by means of percussion. This method of examination is of little use for by it

one cannot even surely establish the presence of two kidneys. The area of dulness due to the kidney is so obscured by the surrounding muscles and by the colon, which may be empty, or full, or distended with gas, and is so much influenced by the variable amount of fat around the kidney itself, that one would not be justified in trusting to the results of percussion when deciding any important question,—for example, whether the presence of a second kidney makes it absolutely safe to remove one which is diseased.

Fig. 66.



Area of renal dulness: *Om*, *Um*, upper and lower levels of splenic dulness; *Ol*, *Ul*, upper and lower levels of hepatic dulness; *Aln*, *Arn*, outer margins of renal dulness; *Uln*, *Urn*, lower levels of renal dulness. (Gerhardt.)

Gerhardt places the patient for percussion upon his face, pushing a cushion under the abdomen so as to press the intestine and kidney as far back as possible. The area of dulness which normally exists in the loin extends as far forward as the posterior axillary line. Above, it is continuous with that of the spleen or liver, posteriorly with that of the other side, while below it reaches to the margin of the ilium. (Fig. 66.) The area of dulness of the kidney is lost in this larger area, and the only margin of the kidney which can be shown by percussion is its anterior margin. This is of no interest except in case the kidney is enlarged. In order to determine even so much in regard to the kidney the intestine must be empty. As larger tumors often compress the intestine, depriving it of its normal tone, it is necessary to fill it with

air or carbonic acid gas. For this purpose a soft rubber catheter should be attached to a bulb syringe and passed into the rectum. By this means the lower portion of the colon may be distended with air. The distention gradually passes upward until oftentimes the whole colon becomes visible to the eye and can be mapped out by palpation and percussion. Its relation to the suspected tumor of the kidney can then be accurately determined.

Formerly use was made of the trocar and aspirating-needle in order to establish a diagnosis. At the present time these instruments should not be used for the purpose on account of the risk that fluid may trickle out through the wound, and thus excite or spread suppuration or infiltration of urine, or an echinococcus infection. Dangerous hemorrhage may be produced in this manner. There are instances, however, especially just before operation, in which it is justifiable to employ an aspirating-needle. The needle used should be of small calibre, and it should be so directed as to avoid wounding the peritoneum. This is easily done, since the kidney to be examined is always enlarged, and may be readily crowded backward and punctured under the twelfth rib, at a point just in front of the margin of the sacro-lumbar muscles.

Examination by means of the *x*-ray has recently proved of value in the diagnosis of diseases of the kidney. There are already numerous recorded cases in which surgeons have been able to recognize and afterward to remove calculi from the pelvis of the kidney by this means when the diagnosis without the *x*-ray was obscure or doubtful. This is referred to more in detail in the section on Stone in the Kidney. It is worth noting that Fenwick has employed the *x*-ray during operation upon the kidney. By means of a specially constructed fluorescent screen he looks through the kidney, which has been brought to the surface of the body.

The chemical and microscopical examination of the urine is of great importance in the diagnosis and treatment of the so-called surgical affections of the kidney. Many of these affections are complicated with parenchymatous and interstitial inflammations which are marked by the presence of albumin, casts, and renal epithelium in the urine. Other disorders produce blood and pus in the urine. It is the business of the examiner to determine the origin of the albumin, pus, and blood, with such certainty that a suitable operation may follow the correct diagnosis. This may be very easy or it may be very difficult of accomplishment. Sometimes blood from the kidney clots in the ureters. These clots may be passed with colicky pain into the bladder and finally through the urethra. If the diseased kidney excretes no more urine, such clots may remain for a long time in the ureter and lose their color more or less completely. These fibrinous clots will then be almost white, something like pale earth-worms. Upon microscopical examination it may be possible to find blood-casts, showing that the hemorrhage is from the kidney. Gumprecht says that fragmentation of the

red blood-corpuscles if present to a marked degree shows almost certainly that the blood has come from the kidney. This appearance is apparently produced by the influence of the urea of the renal epithelium upon the blood-corpuscles. It is therefore only observed if the hemorrhage is a small one.

It is still more difficult to determine the origin of any pus which may be mixed with the urine. If the urine also contains the products of a chronic nephritis, such as granular casts, pus casts, and many-sided epithelial cells from the urinary tubules, it is reasonably certain that at least a portion of the pus has come from the kidney. But these specific characteristics may be wanting if the parenchyma of the kidney is already destroyed or the ureter is blocked.

Thompson has proposed a method which is often of service in determining the source of pus. He passes a soft catheter into the bladder and washes the bladder with an indifferent lukewarm solution until the fluid which comes away is perfectly clear. He then closes the catheter and waits ten minutes. The urine which flows through the catheter at the expiration of this time will be clear if the pus comes from the bladder; if it comes from the kidney, the urine will be as cloudy as usual.

But it is not sufficient simply to know whether the pus in the urine has or has not a renal origin. One must know exactly whether both kidneys are healthy, or diseased, or whether only one is diseased, and if so, which one. It is therefore of the greatest importance to obtain the secretion of each kidney separately in order to be in a position to treat the diseased kidney, or, if necessary, to remove it. The success of such an operation obviously depends upon the absolutely certain knowledge of the condition of each kidney. Numerous attempts have therefore been made in order to obtain the urine separately from the two kidneys. Tuchmann was the first who succeeded in doing so. He employed an instrument constructed on the plan of a lithotrite. The shaft was hollow like a catheter, in order to carry off the urine from the bladder. The instrument was passed backward along the base of the bladder until its beak was felt to slip over the elevation surrounding the mouth of one of the ureters. The two blades were then separated and brought together so that they should lightly compress the ureter between them, thereby obstructing the flow of urine from this ureter. By repeating this process the urine from either ureter could be evacuated separately and examined. Even in the hands of the inventor this method was at best a very uncertain one, especially on account of the difficulty which he sometimes experienced of locating the mouth of the ureter.

Silbermann proposed to introduce into the bladder through the catheter a thin rubber bag, and by filling this with mercury to obstruct the flow of urine from the right and left ureter alternately. He never perfected his instrument.

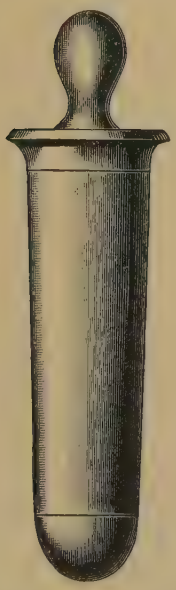
Weir proposed to compress one ureter temporarily by an instru-

ment passed into the rectum. Ebermann suggested that this compression be produced by two blades of the instrument, one of which should be passed into the bladder and the other into the rectum. Hegar proposed to expose the ureter in the vaginal vault and to ligate it temporarily.

Fenwick made a catheter with two openings, each of which had its own canal in the shaft of the instrument. He attempted to collect the urine from one ureter while that from the other was allowed to collect in the bladder and trickle out through the other canal in the shaft of the catheter. The uncertainty of this procedure prevents the instrument from having any practical value.

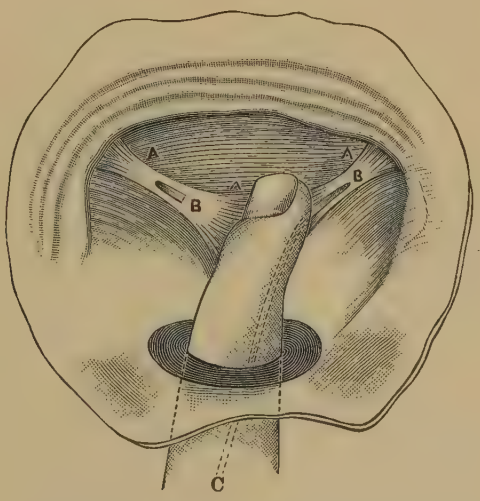
From these early efforts to obtain the urine separately from the two ureters it was only a step to the catheterization of the ureters. This was at first attempted only in the female bladder. Simon was the first one who succeeded, and his method was of limited application and had many disadvantages. He first dilated the urethra by means of hard rubber specula until he could pass his finger into the bladder. The external orifice was nicked with a knife to the depth of 0.25 cm. (0.1 inch) above and to a depth of 0.50 cm. (0.2 inch) below. He then

Fig. 67.



Simon's hard rubber urethral speculum.

Fig. 68.



Ureteral catheterization in the female. A, A, A, interureteral ligaments in base of bladder which serve as a guide to the ureteral openings B, B. C, direction taken by catheter. (Simon.)

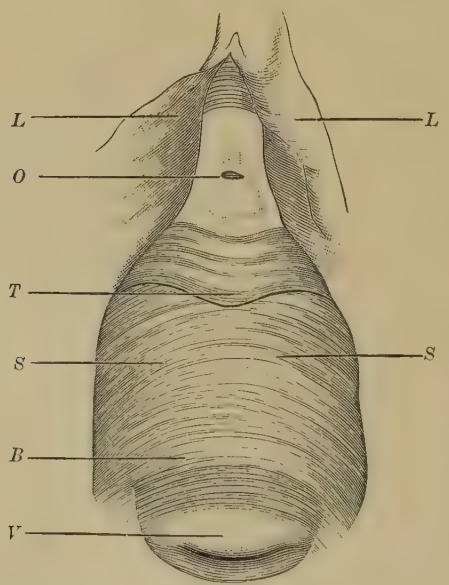
passed seven specula, gradually increasing in diameter from 0.75 cm. to 2 cm. (0.3–0.8 inch). (Fig. 67.) Simon considered it safe to dilate the urethra of an adult up to 1.9–2 cm. (0.75–0.8 inch), while a dilatation of 1.5–1.8 cm. (0.6–0.7 inch) of the urethra of a girl from

eleven to fifteen years was said not to be followed by any serious disorders or permanent incontinence. All these patients suffered after the examination from a temporary incontinence of urine.

When the urethra was fully dilated, Simon passed his left forefinger into the bladder and felt for the little swelling around the ureteral orifice, which is situated about 2.5 cm. (1 inch) from the internal orifice of the urethra. This swelling fades out in the middle line, but is plainly palpable close to the mouth of the ureter, which is situated from 1.25 to 1.60 cm. (0.5–0.6 inch) from the middle line. The mouth of the ureter itself is only a little slit and cannot be felt. (Fig. 68.) The attempt to guide the catheter into the ureter by means of the forefinger is therefore a difficult procedure. Simon himself failed twice in seventeen attempts. In the case of the other patients the catheter was passed without difficulty to the pelvis of the kidney.

The objections to Simon's method are obvious. General anæsthesia is necessary. The complete dilatation of the urethra may leave unpleasant after-effects. It is difficult, and sometimes impossible, to pass a catheter into the ureters by this method.

FIG. 69.



L, *L*, labia minora; *O*, external urethral orifice; *T*, upper end of urethral protuberance; *S*, *S*, oblique grooves; *B*, transverse groove; *V*, cervix uteri. (Pawlik.)

Pawlik showed that if a patient is placed in the knee-elbow position with the abdomen horizontal, and the bladder moderately distended and the perineum drawn backward, two grooves may be seen in the anterior vaginal wall above the urethra (Fig. 69, *S*, *S*.); these extend

obliquely from the middle line outward and upward and often make a triangle with a slight depression (Fig. 69, *B*) just in front of the cervix uteri. This triangle corresponds to the trigonum of the bladder. If, as stated, the bladder contains from 150 to 200 c.c. of fluid, these grooves, which correspond to the ureters, are sufficiently distinct to permit them to be used as guides for ureteral catheterization through the urethra. As soon as the catheter is passed into the bladder its tip must be brought against the bladder-wall by elevation of the shaft of the instrument against the symphysis. Pressure of the tip of the catheter upon the mucous membrane of the bladder can be readily controlled by the finger passed into the vagina. As soon as the tip of the catheter enters the bladder it is passed without any force along the inner side of the diverging vaginal groove. To accomplish this it is slightly rotated on its axis. The surgeon should remember that the mouth of the ureter is not a fixed point, and may vary somewhat according to the distention of the bladder. Hence it is impossible to hit off the mouth of the ureter with mathematical accuracy. The motion described must be repeated perhaps several times in order to accomplish this object.

Another method is to begin with the point of the catheter a little to one side of the middle line, and to carry the instrument forward until a slight resistance is felt. Then its tip is turned to the side. The labia should be held apart lest the handle of the instrument striking against them should mislead the surgeon. As soon as the catheter passes into the ureter there is a sudden disappearance of resistance just as though the instrument had passed into a cavity. As it is passed farther an increasing resistance will begin to be felt. A second sign that the catheter is in the ureter is the intermittent discharge of urine which flows through it. But the surest test is to inject milk into the bladder. If the catheter lies in the ureter, it will continue to discharge urine just as it did before the milk was injected.

Pawlik used either a metal catheter similar to Simon's or a slender elastic catheter with a short metal tip which was introduced with the assistance of a metal shaft 22 cm. (8.8 inches) long. The catheter is fixed in the sheath by means of a clamp. These catheters are 25 cm. (10 inches) long, and the metallic tip is a knob of 1.5 mm. (0.06 inch) diameter.

Pawlik's method was for a long time the best, and by means of it many excellent results have been obtained. True, it was incomplete, for it was only adapted to women, and occasionally failed even with them. Just why the catheter failed to enter the ureter could not be made out. One could not say whether the opening of the ureter was misplaced or covered, or constricted, or whether with the corresponding kidney it was wanting.

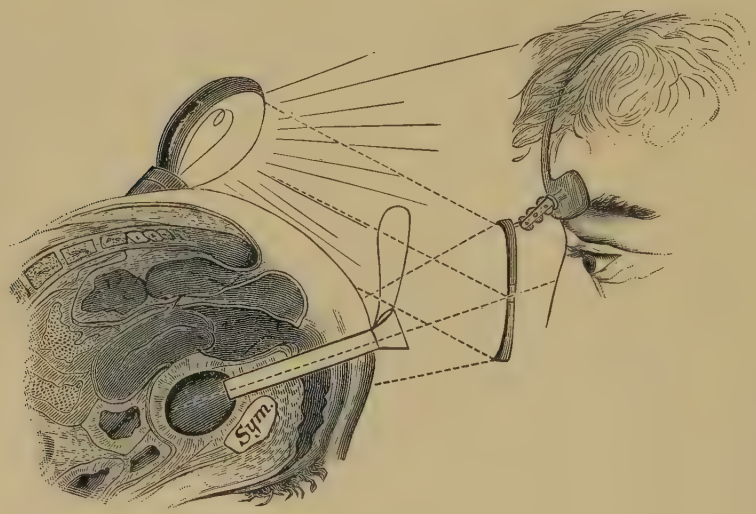
It occurred to several surgeons to utilize Simon's dilatation of the urethra, and to pass an appropriate speculum so as to expose the opening of the ureter and permit the introduction of a catheter under the guidance

of the eye. This proved to be so simple that the wonder is that it was not done before, especially as Desormeaux, Fenger, Grünfeld, and others had shown the possibility of inspecting the whole urethra by means of the speculum and light reflected from a frontal mirror.

Howard Kelly was the first to make a useful instrument by which the ureter can be exposed and catheterized. His method is far in advance of that of Pawlik.

If the examination is to be of short duration, the patient may rest on the knees and elbows. If the catheterization is to be thoroughly done, the patient should lie on the back with the thighs widely separated and the pelvis elevated from 20 to 40 cm. (8-16 inches) above the shoulders. By Hegar's dilator the urethra is gradually stretched until its calibre exceeds in diameter by 2-3 mm. (0.08-0.12 inch)

FIG. 70.



Examination of the bladder through a speculum. (Kelly.)

that of the speculum to be used. The speculum is introduced with an obturator. Those which Kelly uses are like Simon's except that they have a handle at one side. They are 8 cm. (3.2 inches) long and of different diameters, from 5–12 mm. (0.2–0.5 inch); but that having a diameter of 10 mm. (0.4 inch) is usually employed. As soon as the speculum enters the bladder this organ becomes distended with air, since its posterior wall is dragged away by the weight of the abdominal organs. The space thus gained in the bladder measures 2–5 cm. (0.8–2 inch), something which must be reckoned upon in handling the instruments. (Fig. 70.) In order to expose the mouths of the ureters the axis of the speculum must deviate about 30 degrees from the long axis of the body. Kelly says that it is not difficult to

find the opening of the ureters,—at any rate if the ureteral swelling is prominent. If this fails, the surgeon has nothing to look for excepting a very small slit, which is often hidden in the folds of mucous membrane. This makes the catheterization much more difficult; but even in the simpler cases a certain amount of practice is necessary. Kelly first passes into the ureter for a distance of 2 or 3 cm. (0.8–1.2 inches) a metal probe in order to be sure that the ureter is located with certainty. He then withdraws this and passes an elastic catheter to the pelvis of the kidney. The bladder is lighted by means of daylight or electric light reflected from the concave frontal mirror. The urine which collects in the fundus of the bladder during the examination is sucked out from time to time by a bulb syringe and a rubber catheter introduced for the purpose through the speculum. Or, it can be wiped up with a little tampon of absorbent cotton. In order to facilitate the finding of the ureter Kelly marks a point on the speculum 5.5 cm. (2.2 inches) from its vesical end and draws from this two diverging lines toward the bladder which include an angle of 60 degrees. The axis of the instrument bisects this angle. If the speculum is passed the required distance and then swung to the side until one of the lines corresponds with the axis of the body, the axis of the instrument deviates from this 30 degrees and will therefore be directed practically to the mouth of the ureter.

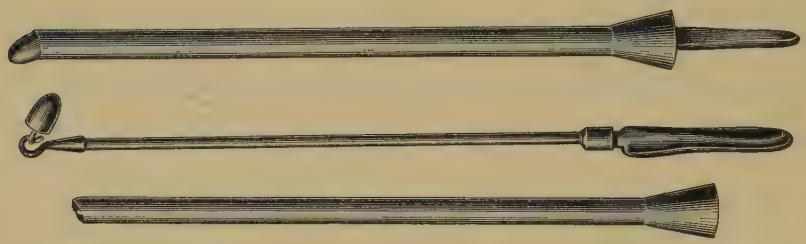
Rose has recently proposed a method of obtaining the urine from one ureter which is extremely simple: He cuts a Simon speculum obliquely from behind forward so that it can be pressed against the wall of the bladder around the mouth of one ureter. As the urine collects, it is sucked out with a syringe. The possibility of obtaining separated urine by means of this instrument depends upon the fact that when the pelvis is much elevated the mouths of the ureters are situated at about the summit of the bladder. Therefore, the urine which comes from the other ureter settles in the bladder without mixing with the urine in the speculum. It is either necessary to cocainize the bladder or to give the patient an anæsthetic. One advantage of this method is that it enables the surgeon to collect separated urine without passing instruments into the ureter. This point is discussed further on.

R. T. Morris has made attempts to expose the mouths of the male ureters with relatively wide tubes. These tubes are straight, cut off somewhat obliquely from behind forward, 22 cm. (8.8 inches) long and 9 mm. (0.36 inch) wide. The conical obturator has a length of 15 mm. (0.6 inch), and is hooked to a middle rod so that it is slightly tilted in the mouth of the instrument and will form a beak with Mercier's curve. (Fig. 71.) This facilitates the passage of the instrument. When the point of the instrument is in the bladder, the obturator is pushed forward and no longer obstructs the view.

While the instruments heretofore described were being perfected, other surgeons were working along other lines to accomplish the same

results. In 1876 Nitze hit upon the idea of examining the bladder by means of a cystoscope, an instrument which should illuminate the bladder from within. Naturally the source of light could only be electricity. By means of patient effort, in which he was joined by many others, such as Hill, Fenwick, Thompson, Boisseau du Rocher, Casper and Albarran, and by Leiter, an instrument-maker of Vienna, the cystoscope has been so improved for use upon men and women that it leaves little to be desired.

Fig. 71.



Endoscopic tube. (Morris.)

With the help of this instrument the surgeon is enabled to judge of the condition of the kidneys, not only by noting the condition of the mucous membrane of the bladder, but also by direct inspection of the mouths of the ureters. One can without much difficulty watch the jets of urine flowing from the ureters into the bladder. If the urine from one ureter is abundant and clear, while that from the other is scanty and full of pus or blood, the important question as to the origin of pus or blood in the voided urine is settled at once. In other cases the mouth of the ureter will be found to be inflamed or ulcerated, the ulcer perhaps extending a little way in the vesical mucous membrane, or a plug of mucus may be hanging from the ureteral opening. Furthermore, a negative result of the examination may be of value. If upon examination only one ureter can be found, it is probable that the other one does not exist, and that the corresponding kidney is wanting. But even more may be done with this instrument. It may be so constructed that elastic catheters may be passed from the bladder into the ureters and there left to furnish separated urine. Nitze was not the first to construct an instrument of this sort, but he was the first to construct it on the right principle. Others who preceded him constructed other instruments so that the elastic catheter emerged from the instrument in its long axis. This made it extremely difficult, or impossible, to pass the catheter into the ureter. Nitze's instrument is a cystoscope with a metallic sheath in which an elastic catheter can be introduced. The direction which this catheter usually takes on leaving the shaft of the instrument is about the same as that of the beak of a cystoscope; hence the instrument is made to have two branches, the upper one carrying the electric light and the lower one the catheter. When the instrument is

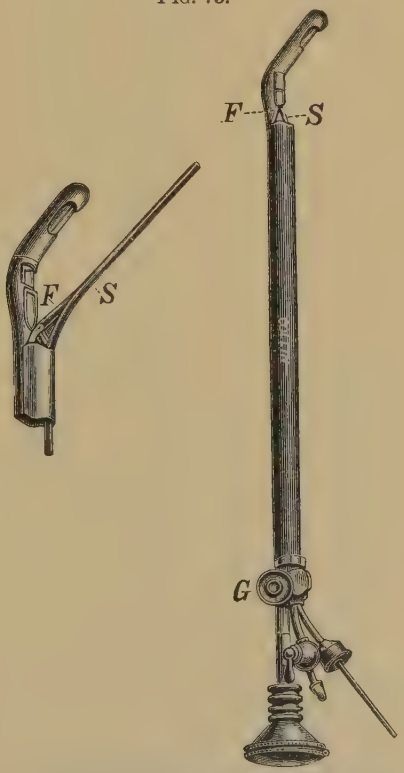
introduced, these two branches lie together like the blades of the lithotrite. After they have entered the bladder they are separated. This instrument has two defects. Sometimes the friction of the catheter is so great that it is difficult to withdraw the cystoscope and leave the catheter in place. The second defect is the fact that the beak which directs the catheter maintains a fixed and unalterable angle with the shaft. These defects are avoided in Casper's cystoscope, an instrument first described in 1895.

In Casper's cystoscope the catheter lies in a groove which may be closed

FIG. 72.

Casper's ureter cystoscope: *L*, lamp; *P*, prism; *D*, canal for the catheter with a sliding cover; *C*, catheter; *O*, ocular.

FIG. 73.



Albarran's ureter cystoscope. The curve of the catheter *S* can be altered by screwing forward or backward the staff *F* by means of the screw *G*.

or opened by a slide. Furthermore, this slide may be used to alter the angle with which the catheter leaves the shaft of the instrument. If the catheter is not affected by the slide, it leaves the axis of the

shaft at a narrow angle; if pushed upon by the slide, it leaves the axis of the shaft more nearly at a right angle. In order to free the catheter from the cystoscope the former is pushed well into the pelvis of the kidney and the slide is withdrawn. The slide is then reinserted under the catheter, thereby freeing the catheter entirely from the cystoscope. When the instrument is withdrawn, the catheter remains in place; or, before the cystoscope is withdrawn, a second catheter may be inserted and passed into the other ureter.

Lohnstein improved this instrument still further by shifting the position of the electric light from the point of the cystoscope to the junction of the beak and the shaft. This permits of the construction of a cystoscope with a beak at any desired angle. The latest type of Casper's ureter cystoscope is shown in Fig. 72.

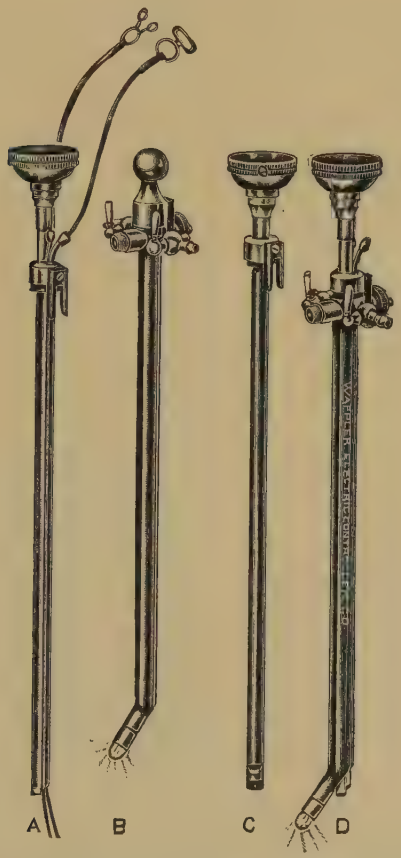
The axis of the ocular was formerly 2 cm. (0.8 inch) deeper than that of the groove for the catheter; hence it was necessary to insert a second prism, which reduced the clearness of the field of vision. In the new cystoscope this prism is not necessary as the outer part of the groove for the catheter is slightly bent upward, and the lever *H* is introduced to make more accurate the forward and backward motion of the slide *D*. The calibre of the optic canal is reduced while that of the catheter is increased until it will take a No. 8 Charrière. If a smaller catheter is to be used, tubes (*K* and *K'*), 17.5 cm. (7 inches) long, are placed in the groove for the catheter. These all accurately fit the groove, but their calibres vary.

Albarran's instrument (Fig. 73) is similarly constructed. Its object is to alter at will the direction of the point of the elastic catheter. This is done by making the catheter pass over a middle blade whose position can be shifted from horizontal to vertical. The direction of the point of the catheter varies with the position of this blade.

Tilden Brown has devised one of the simplest and at the same time most serviceable of catheterizing cystoscopes. In this instrument the sheath is oval in order to permit of a larger telescope associated with the two catheter canals. (Fig. 74, A, B, C, D.) The terminal or intravesical lens projects beyond the heel of the sheath, so that it comes nearer to the lamp, and in this way a better illumination and a clearer field are gained. The catheter canals also form part of the projection going forward almost to the same level as the terminal lens. This arrangement gives the flexible catheter the necessary support to overcome an opposition sometimes offered by the ureter mouths or just within. In the vast majority of cases Brown uses the short catheter. The prismatic retrograde telescope also protrudes beyond the sheath, but to a much greater degree than the catheterizing telescope. This is in order to get the benefit of lamp proximity as well as to have the lamp in view when desired to use this beak of the instrument as a probe for moving foreign bodies or testing the attachment of a tumor. This retrograde tube turns with the sheath or independently; ordinarily it is turned so that the lamp is just out of the vesical field.

The ureter cystoscope is used according to the following principles: The sterilized silk catheter, stiffened by means of a wire passed to within 5 cm. (2 inches) of its point, is placed in the cystoscope. The urethra is cocainized. When the cystoscope is in the bladder the patient will be unconscious of the passage of the ureteral catheter provided it does not touch the vesical mucous membrane. This is easily avoided if

FIG. 74.



A, the catheterizing telescope, with a short catheter in each canal. B, the open sheath with obturator in place to facilitate introduction. On entering the bladder the obturator is withdrawn and one of the telescope tubes inserted. Such arrangement prevents the risk of infection being carried from the urethra by the catheter canals or catheter. C, an interchangable prismatic retrograde telescope. D, the sheath with catheterizing telescope inserted. Note the projection of the intravesical end of the telescope beyond the sheath.

the bladder contains 150 or 200 c.c. of fluid. The cystoscope should also be passed well back in the bladder before the catheter is pressed forward. If the catheter touches the wall of the bladder, it may cause slight hemorrhage. As soon as the mouth of the ureter is found, the cystoscope should be so directed that the ureter occupies

the lower margin of the inner field of vision. The catheter is then pushed slightly forward so that the direction of its point may be observed. By raising and lowering the cystoscope, drawing it forward and backward, and turning it from left to right, the surgeon can direct the point of the catheter exactly into the mouth of the ureter. It is desirable to bring the instrument close to the ureter before passing the catheter into it. Thus in catheterization of the left ureter the ocular end of the cystoscope should be swung to the right, and *vice versa*. Furthermore, if the ocular end of the instrument is raised, the vesical end is brought nearer to the base of the bladder, and hence to the left of the ureter.

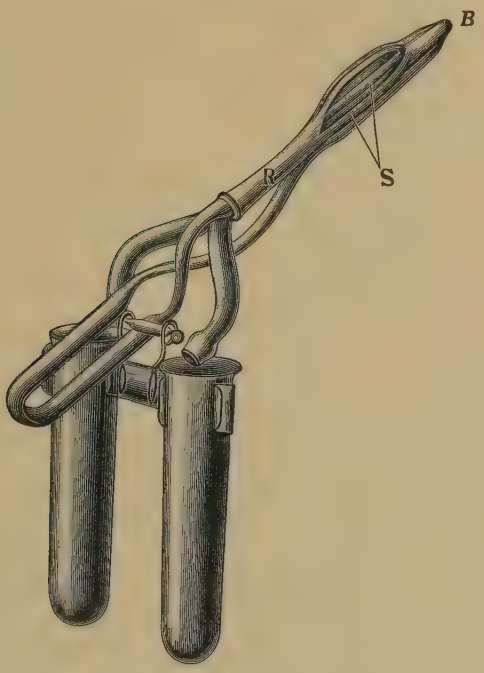
If the point of the catheter does not enter the ureter, its direction must be changed by moving the slide of Casper's instrument forward or backward, or by turning the screw of Albarran's instrument. The point of the instrument will then reach a plane which it could not reach before its direction was altered. If the catheter enters the mouth of the ureter, the slide of the cystoscope should be somewhat withdrawn in order to reduce the angle at which the catheter is bent and to facilitate its further passage. The wire is withdrawn from the lumen of the catheter, and the urine flows immediately or after a few minutes. It does not come in a steady stream, but drops irregularly on account of the peristaltic action of the ureter. If it comes steadily, the point of the catheter lies either in the bladder or in the pelvis of the kidney. Unless it is desired to determine the lumen of the ureter, it is better not to push the catheter further in after the urine is obtained. The failure of urine to flow from the catheter which is in the ureter may be due to a temporary ureteral spasm, or to a kink in the catheter, or to pressure of the mucous membrane of the ureter into the eye of the catheter. Similar causes may prevent the catheter from being pushed onward; or this may be prevented by a wrong angle of the catheter. Such difficulties may be overcome by a change in the slide, by a slight withdrawal of the catheter, or by the injection of a few drops of aseptic fluid. If the ureter is blocked by a stone, the obstruction cannot, of course, be overcome in this manner.

The cystoscope may be disinfected by letting it lie for twenty-four hours in a 3 or 4 per cent. solution of carbolic acid. Oil can be removed from its surface by wiping it with ether. One should be careful not to allow water to flow through the ocular into the tube. The ureteral catheter may be disinfected by a 1 : 1000 solution of bichloride of mercury, and the nickeled stylet by a carbolic solution. Both instruments may be disinfected by formaldehyde gas. The cystoscope and the catheter may be lubricated with glycerin, lanolin, or lubrichondrin, all of which should be sterilized. The eye of the catheter should not be blocked with the lubricant.

The risk of infection of the ureter is extremely slight even if the bladder through which the catheter must pass contains germs. This

risk is much reduced by a careful irrigation of the bladder with a solution of boric acid before the catheter is introduced. It is, however, desirable to avoid any unnecessary injury of the mucous membrane. The periodic flow of the urine through the ureter is of itself a great protection against infection. If one wishes to be absolutely safe, the ureter may be washed out with a 1 : 1000 solution of silver nitrate. The amount of urine which flows from a ureter within a given time varies so, and is dependent upon so many factors, that it is not safe to draw any diagnostic conclusions from it. It will average about 6–10 c.c. (ʒiss-ʒiiss) in ten minutes. In about one-half of the cases the

Fig. 75.



Neumann's instrument for collecting separated urine.

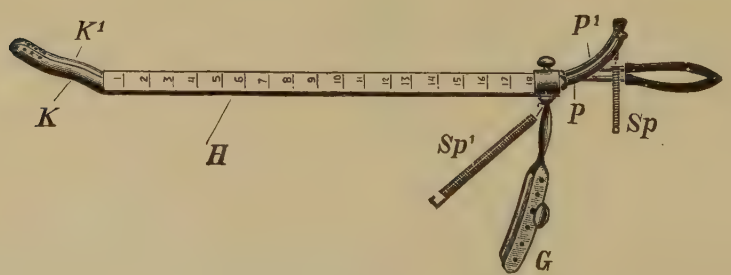
urine will contain some red blood-cells, due either to slight injury of the mucous membrane, or to the hyperæmia which the irritation of the catheter induces. If due to the former cause, the bleeding is most marked at first. If due to the latter, it gradually increases. In both cases it disappears if the catheter is pushed a little higher upward.

In spite of the success which has crowned the efforts of those who have developed the cystoscope, men have not given up the attempt to obtain the urine separately from the ureters by other methods. The use of the cystoscope requires a considerable practice and a dexterity which not every one possesses. Neumann attempted to make an

artificial wall at the base of the bladder which should keep separate the urine from the right and left kidneys until it could be collected. He made a tube of thin metal 4 cm. (1.6 inches) long and 1 cm. (0.4 inch) in diameter (Fig. 75, *B*). Within this tube is a solid dividing wall which projects 4 cm. (1.6 inches) beyond it so that the total wall dividing the two sides measures 8 cm. (3.2 inches) in length. Each half of the instrument terminates in a tube from which urine flows into separate glasses. The dividing wall which passes into the bladder terminates in a blunt point (*B*). On either side of the instrument is an opening to admit the urine, separated by a septum (*S*). The whole instrument has a slight upward curve so that it shall adapt itself to the posterior surface of the symphysis. The patient sits well forward on the edge of an operating-table with the thighs separated and the feet raised on stools; the instrument is inserted with its concave surface directed forward, and as its diameter is only slightly greater than that of the urethra, it is introduced without difficulty. The bladder is irrigated with warm boric acid solution through one of the tubes described. When this has been done the finger of the surgeon is passed into the vagina in order gently to stretch the base of the bladder upward along the instrument until its point is reached. This point should lie exactly in the median line, and should be lightly pressed forward against the symphysis. As the mouths of the ureters are separated by a distance of about 3 cm. (1.2 inches) there is little danger, according to Neumann, that this dividing wall shall not lie between them.

By working on the same plan, Harris, of Chicago, has developed an instrument capable of being used to collect urine from each ureter in the case of male or female patients. It is a combination of two catheters (Figs. 76 and 77, *K* and *K'*) whose separate shafts, 20 cm.

Fig. 76.

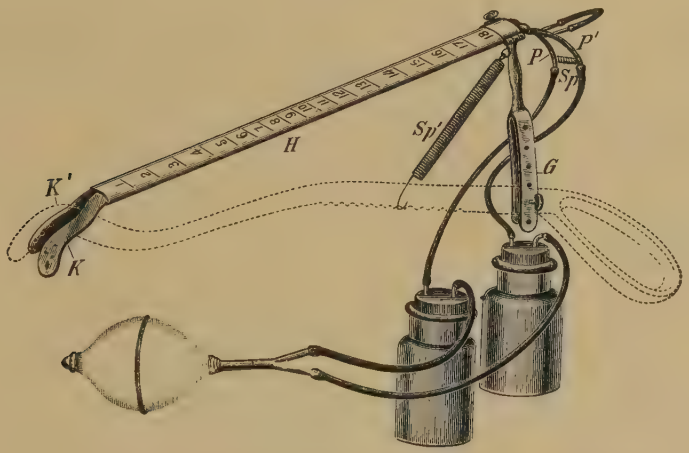


Harris' instrument for collecting separated urine. Closed for introduction.

(8 inches) long, are enclosed in a common tube (*H*). The distal portion of the tube is somewhat flattened and has a peculiar shape. It begins to curve like an ordinary male catheter at an angle of 60 degrees with a radius of 3.5 cm. (1.4 inches); the tip is slightly curved in the opposite direction. When these two halves are approximated, they form a

rounded whole. The proximal ends of both catheters are curved upward (P, P'), and each catheter can be rotated within the sheath, so that the distal and proximal ends of each can be turned symmetrically away from those of its fellow. (Fig. 77.) This motion separates the flat surface of the distal ends of the catheters (K, K'), and exposes a number of fine openings into the lumina of the catheters. A small spring ($Sp.$)

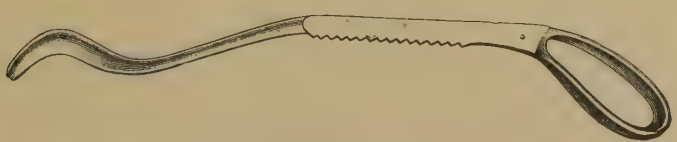
Fig. 77.



Harris' instrument for collecting separated urine. Open for collecting urine.

holds the catheters in the correct position. The proximal ends of the catheters are connected by rubber tubes with two small glass bottles from which air can be sucked by means of a bulb syringe. In addition to the parts described there is a metallic rectal lever about 25 cm. (10 inches) long, flattened from side to side and peculiarly curved, as shown in Fig. 78.

Fig. 78.



Harris' instrument for collecting separated urine. Rectal lever.

The instrument is used as follows: The patient is placed in the lithotomy position, and the catheters are approximated and introduced into the bladder. Each catheter is then rotated so that its beak is directed downward until the two form with each other an angle of 100–110 degrees. They are held in this position by a fine spiral spring (Sp). The distal ends of the catheters are then sufficiently separated so that there can be no risk of compressing the mouths of

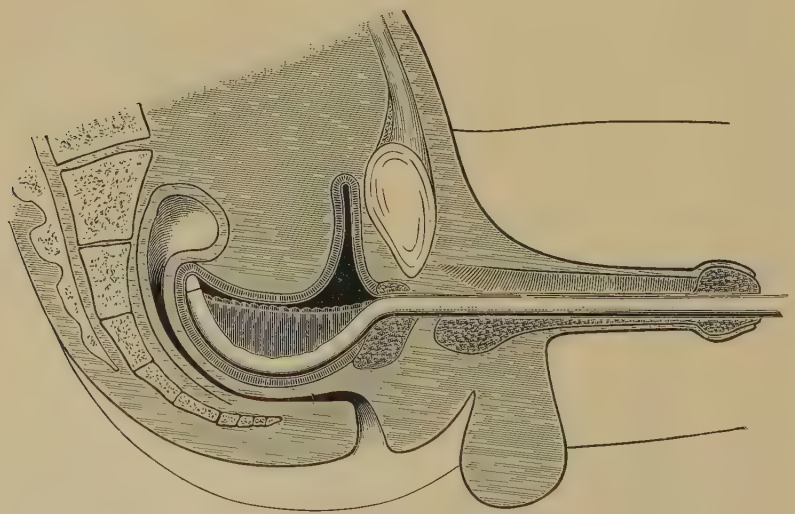
the ureters. Next the lever is introduced into the vagina or rectum and elevated until it forms a fold in the base of the bladder. This fold forms a watershed between the openings of the ureters, and the urine from either kidney collects on its own side of the watershed and is sucked out through the catheter. A forked eye (*G*) and spiral spring (*Sp'*) hold the lever of the catheter in the proper position. By

FIG. 79.

Urine segregator, pattern of Luys.

means of a bulb syringe urine can be sucked from each side of the bladder and deposited in the bottle just as fast as it flows from the ureter. This instrument is extremely simple and has answered its purpose, not only in the hands of its inventor, but in those of others who have tried it.

FIG. 80.



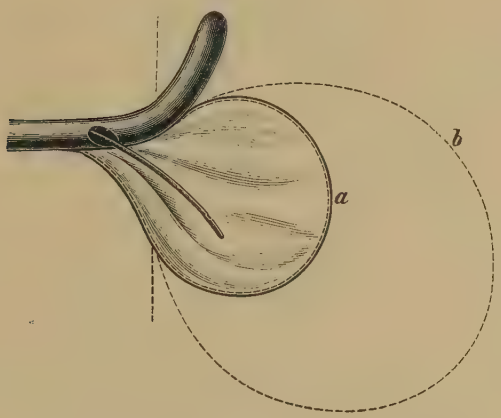
Showing Luys' instrument in position.

Luys has devised an instrument consisting of two catheters between whose tips there is a curved metal piece. The latter can be bent still

more by means of a chain reaching to the handle of the instrument. This chain thus forms the string to a bow. Over the curved metal strip and the chain is a thin rubber covering. In this manner a partition is formed the curved edge of which is directed backward, fitting against the wall of the bladder, and separating the urine from the two ureters. The patient sits on the edge of the table, and the surgeon's finger in the rectum aids in keeping the posterior wall of the bladder against the septum of the instrument.

A similar instrument in simpler form was suggested by Guyon in 1902, and has been perfected by one of his assistants, Cathelin. It is shown in Figs. 81 and 82. Through a slit in the convex side of the catheter-shaped instrument, a fine spring can be pushed out.

FIG. 81.



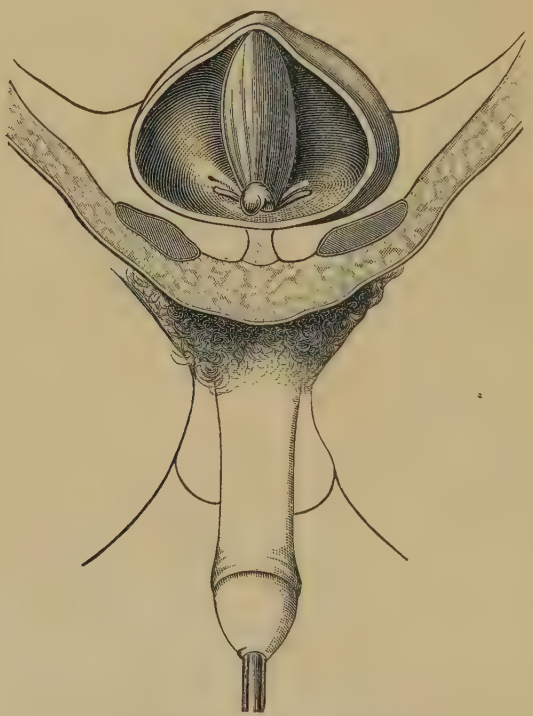
Cathelin's instrument for obtaining separated urine.

The spring (*a–b*) is covered with a thin rubber bag. The septum thus formed will fit accurately the posterior wall of almost any bladder, even though it holds only 18 c.c. Two fine catheters for collecting the urine can be passed through eyes in the main instrument, so as to emerge on either side of the septum. The spring must be wholly withdrawn into the instrument before the instrument is withdrawn from the bladder. The instrument is said to be accurate, and it is especially to be recommended as causing no pain to the patient.

One of these instruments or some other of a similar nature is likely to obtain a permanent place alongside of the ureter-cystoscope. In skilful hands the latter instrument has the advantage of absolute certainty. Its value, however, should not be overestimated. The methods of using it are by no means perfect, and the difficulties are at times so great that the instrument cannot be used at all. For example, a urine which is continuously clouded or bloody will so interfere with the use of the cystoscope that catheterization of the ureters is impossible. If the

bladder has lost its elasticity, as it may if tuberculosis is present, detection of the mouths of the ureters is difficult or impossible. In such cases Harris's instrument will promise better success than the cystoscope, and will be less apt to lead to errors of diagnosis, since it is less likely to set up hemorrhage than the cystoscope. Both instruments are subject to criticism from the fact that the analysis of a small amount of urine has less value than that of a larger quantity. One great advantage which Harris's instrument possesses over the cystoscope is that by it separated urine is obtained without passing catheters into the ureters. It is true that the risk of infection in the ureters is

FIG. 82.



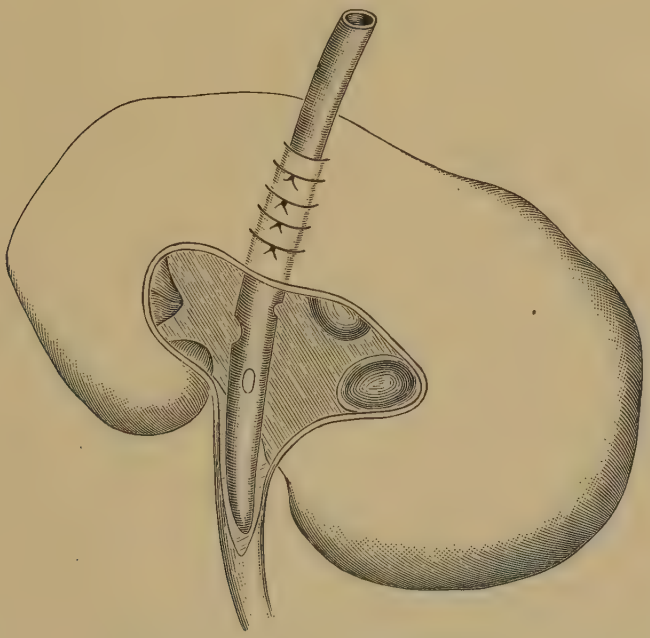
The Cathelin instrument in place.

extremely slight. Some surgeons have catheterized the ureters hundreds of times without harmful result; but the possibility of infection must be admitted, so that most surgeons prefer not to catheterize the ureters if tuberculosis of the bladder exists. This rule excludes a considerable number of cases in which it is most important to analyze the urine as it comes from each kidney. It was formerly considered unsafe to continue the use of either instrument for more than an hour; but Illyes has left ureteral catheters in place twenty-four hours without bad result.

If the surgeon is unable by the methods described, to obtain separate urine from each kidney, or if the examination of such small quantities of urine is not sufficient to determine whether or not the condition of one kidney is such that the other may safely be removed, still other methods of examination may be tried.

1. The ureters may be catheterized after the bladder has been opened above the pubes. This plan of procedure was recommended by Iversen in 1887; to-day it has been superseded by the ureteral cystoscope, and would only be followed in case it was impossible to catheterize the ureters through the urethra. After the bladder has been opened, the mucous membrane of the base of the bladder is drawn upward with sharp hooks until the mouths of the ureters are

FIG. 83.



Ureteral catheterization from the kidney. (Pinner.)

detected. Into each one is passed a catheter which is indelibly marked in some manner. A lithotrite is passed into the bladder through the urethra and the free ends of both catheters are grasped by this instrument and brought out through the urethra. They may be left in position for twelve hours without serious result.

2. A temporary fistula of the pelvis of the kidney may be established in order to obtain the urine from one kidney while that from the other flows into the bladder. This method, which has been employed by Czerny and Braun, presents the disadvantage that it does

not absolutely prevent the flow of some urine from the incised kidney through its ureter. Israel suggests ligation of the ureter. This should not be performed unless the surgeon is convinced that he is not going to close the fistula later. Pinner proposes temporary closure of the ureter by compression or light ligature.

3. The ureter may be catheterized through the kidney according to the method devised by Pinner. (Fig. 83.) The usual lumbar incision is made and the kidney is incised in its convex border; or an incision is made posteriorly into its pelvis, according to circumstances. In either case the pelvis is opened and a Nélaton catheter is passed into the ureter for a distance of 2 or 3 cm. (0.8 or 1.2 inches). The point of this catheter should be solid, so that it may block the ureter, while the eye of the catheter opens into the pelvis of the kidney. To insure further the complete obstruction of the ureter a light ligature is passed around the ureter and catheter. The accuracy of the closure of the ureter may be tested by the introduction of a solution of methyl-blue into the renal pelvis, followed by the passage of a urethral catheter into the bladder. The ureteral catheter is fixed in the kidney by a few sutures, which may be applied in the same manner as the sutures in Witzel's gastrotomy if the kidney is atrophied and distended so that its cortex is very thin.

4. The surgeon may palpate both kidneys through a median abdominal incision, as practised by Tait and Thornton.

5. The kidney to be extirpated may be exposed through a lumbar incision. Before it is opened, the hand may be passed through the wound into the peritoneal cavity in order to palpate the other kidney. According to the results of this examination the kidney known to be affected may or may not be removed (Kocher's method).

6. Edebohls exposes both kidneys by lumbar incisions, frees them, and brings them to the surface for inspection, palpation, incision, drainage, resection, for microscopical examination, etc. On the result of the examination will depend the treatment of the kidneys. They may be replaced, or excised, or one may be removed while the other is replaced.

It is evident that the method last spoken of is the most radical of all, and affords the greatest certainty in judging of the condition of both kidneys, especially if one combines this method with that of Pinner. It cannot be denied that such a method of examination is severe, and that in many cases it is unnecessary, especially if one is able to palpate the second kidney without making a second incision. Pinner's method is usually successful in deciding whether it is permissible to extirpate the kidney.

The importance of a most exact and careful analysis of the urine before deciding upon surgical treatment of the kidney can hardly be overstated, since the choice of treatment often rests entirely upon the results of such an analysis. It is unnecessary in this place to speak of the chemical, microscopical, physical, and bacteriological methods

of examination, but it may not be out of place to call attention to a new method of determining the quantity of uric acid and urates in the urine. The test referred to shows whether the products of albuminous degeneration are promptly excreted or whether they are collecting in the body.

The first method of investigation suggested for this purpose is the determination of the total quantity of urea excreted in twenty-four hours. This is a very simple method, but it is somewhat unreliable, for the reason that the quantity of urea excreted daily varies greatly even in normal conditions. The normal daily quantity may be considered as 20–25 grammes, while a diminution of one-half or more, so that the quantity is less than 15 grammes, points to insufficient action of the kidneys, which renders inadvisable the extirpation of one organ. It is not enough to determine the quantity of urea for a single day on account of the variation referred to, which is even more marked in many cases of nephritis. Hence the examination should rather be made for several successive days.

The quantity of urea is easily and satisfactorily determined by means of Esbach's apparatus. It is only necessary to read the scale on the glass cylinder and to compare it with a table in order to determine the percentage of urea contained in the specimen of urine examined. If the quantity of urine passed in twenty-four hours is known, it is easy to reckon the total quantity of urea excreted.

Recent investigations by Koranyi, Lindemann, Richter, Roth, Senator, Casper, and Moritz have shown that the activity of the kidney can be determined by other methods with a degree of certainty which older methods do not possess. Their work is based on the principle that in accordance with the loss of osmotic pressure solutions of different concentrations possess different freezing-points. The more concentrated is the solution, the lower is this point. The lowering of the freezing-point of a watery solution below the freezing-point of distilled water is in direct proportion to the quantity of the substance held in solution. Consequently, the determination of the lowering of the freezing-point of urine must give a valuable indication as to its concentration, and therefore as to the work the kidneys are doing. But the determination of the freezing-point of the blood has proved to be a still more valuable diagnostic sign. For the sake of brevity, the freezing-point of the urine is designated by a triangle ($\triangle$), while that for the blood is designated by the Greek delta (δ). The term cryoscopy is used to indicate the tests to determine the molecular concentration of the urine and the blood.

It is evident that the concentration of the urine, and hence its freezing-point, are subject to great variations according to the quantity of fluid which the individual drinks. Lindemann finds that the freezing-point ranges normally from 1.3–2.3 degrees C. below that of distilled water, while other investigators give it a range of 0.9–2 degrees C. They are pretty well agreed that when the freezing-point is

less than 0.9 degree C. below that of water insufficiency of the kidneys is indicated. The diagnostic value of △ is naturally far greater when it can be determined, not for the total urine excreted, but for that excreted by each kidney separately.

The freezing-point of the blood of a healthy individual is said to be 0.56 degree C. below that of water. This point is so constant that it varies scarcely 0.01 degree C. in health. Under pathological conditions there are certain fixed variations from the normal. Thus, if the patient is markedly anæmic or cachectic, the freezing-point of the blood will be less than 0.56 degree C. above that of water. But it will be below that if carbonic acid is increased in the blood. Furthermore, the freezing-point falls whenever the activity of the kidney is deficient. This fall may be distinguished from the fall due to an excess of carbonic acid, since it is not influenced by oxygenatien of the blood, whereas the fall due to carbonic acid disappears if the blood is shaken with oxygen. Acetonæmia produces a change in the freezing-point of the blood. The sinking of the freezing-point observed in this condition is increased by the passage of oxygen through the blood, probably because the oxygen changes some unknown substance in the blood into acetone.

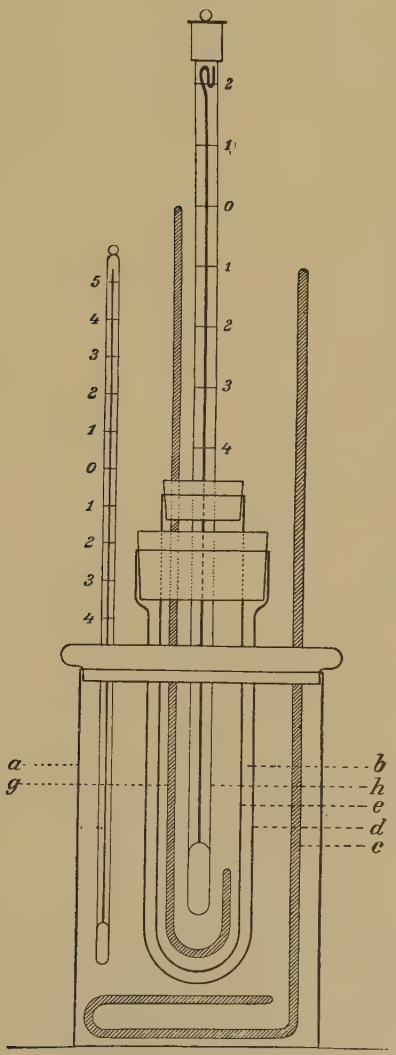
It is readily seen that this method of examination has a most important bearing upon surgical diagnosis of diseases of the kidney, and especially upon the quesion whether it is safe to remove one kidney. The important question to determine is whether the remaining kidney will be able to do the work of both. It has already been stated that an attempt to settle this question from an examination of a small quantity of urine drawn through a ureteral catheter frequently fails. The certain proof that the metabolism of the body is going on in a normal way in spite of the fact that one kidney is so diseased that its removal is imperative, must in many cases be a better proof of the functional activity of the other kidney than all other methods of investigation which are at present known. One must, however, be sure that the diseased kidney whose removal is contemplated, does not itself possess a fair degree of functional activity.

Koranyi also learned that if there is insufficiency of one kidney, its effect upon the freezing-point of blood may be influenced in a remarkable way by changes in diet. The reduction of the freezing-point of the blood due to renal insufficiency is largely overcome by a diet consisting chiefly of carbohydrates. The lack of carbohydrates favors the formation of acetone from albumin, and small quantities of acetone markedly lower the freezing-point of the blood.

Kümmel is of the opinion that a fall of the freezing-point of the blood to —0.58° or —0.60° C. is proof that both kidneys are acting insufficiently, for a single kidney doing its normal work will keep the freezing-point from falling below —0.56° C. Unless the freezing-point of the blood is —0.56°, or higher, the removal of one kidney must be regarded as dangerous. When he removed one kidney from a patient whose blood froze at —0.58° C. the convalescence was very tedious.

Further experience is necessary in order to show whether this hard-and-fast rule is always to be followed. Indeed, Landau has mentioned a successful extirpation of the kidney in which the freezing-point of the blood was —0.60°, and Viebrecht successfully removed a cancerous

Fig. 84.



Beckmann's freezing apparatus.

kidney when the blood had the same freezing-point. The urea excreted by the other kidney alone was present to the extent of 1.78 per cent., and the urine had a freezing-point of —1.35°. Two days after the

extirpation of the kidney the freezing-point of the blood rose to —0.58°, and later to —0.56°. Apparently the tumor itself, by the discharge of degenerative products of metabolism into the circulation, reduced the freezing-point.

Technic.—The best apparatus to determine the freezing-point is that devised by Beckmann. (Fig. 84.) This consists of the glass vessel *a*, in which a temperature of 4° C. is maintained by a mixture of ice and salt, or a solution of ammonium nitrate in water. This temperature must be maintained by additions of the freezing mixture. The bent wire *c* is sunk in the freezing-mixture in order to stir it about and cause a more rapid solution of the salt. The wide glass tube *d* contains a narrower tube (*e*), in which is placed the fluid to be examined. Between these two is an air space (*b*) so that the fluid to be examined does not come directly into contact with the freezing mixture. The wire *g* is placed in the fluid to be tested in order to stir it, and also a thermometer (*h*) in which 1 degree C. is divided into a hundred parts. The scale is regulated so that the zero point corresponds to the freezing-point of distilled water.

With such an apparatus at hand a hollow needle is passed into the distended vein of the arm and about 20 c.c. of blood are drawn into the small glass and immediately defibrinated by stirring it with a platinum wire (*g*). The temperature of the freezing-mixture is then reduced to 4° C. and kept there; at the same time the fluid to be examined is kept in constant motion by stirring. The mercury in the thermometer (*h*) will sink several degrees below 0 before freezing of the blood occurs. At the moment, however, that the blood freezes, the quicksilver rises rather rapidly to a certain height and remains there; the mark at which it stands indicates how much below the freezing-point of distilled water is the freezing-point of the mixture in the glass. The freezing-point of distilled water varies slightly with changes of the barometer.

There is still another way in which to test functional activity of the kidney. Mering discovered that phloridzin has the property of producing an artificial glycosuria which differs from all other artificial glycosurias since it is not accompanied with increased sugar in the blood. Further investigation proved that the sugar was formed from the phloridzin by the activity of the kidney. Klemperer, Achard, and Delamare thought if the kidneys were diseased the administration of phloridzin would be followed by little or no sugar in the urine; and Caspar hit upon the notion of utilizing the phloridzin reaction to test the capability of the kidneys. He drew the separated urine by ureteral catheters. He found that a healthy kidney excretes the same quantity of sugar in a given time whether the test is made in the beginning or at the end of the period of glycosuria. For practical purposes the test is usually made from a half hour to an hour after the phloridzin has been injected. With rare exceptions the excretion of sugar and urea and the molecular concentration of the urine are the

same; but of the three, the phloridzin reaction is held to be the most sensitive test. It is certainly a valuable addition to the different methods of investigation. Caspar injects subcutaneously 0.005 gramme of phloridzin. Exceptionally, in the case of very large persons, he doubles the dose. The strength of the solution is 1 : 200, and it is boiled immediately before the injection. This dose is absolutely harmless. The amount of sugar may be quantitatively determined by polarization, or the ordinary drop method, or, still better, by Cohnstein's fermentation saccharometer.

CHAPTER X.

CONGENITAL ABNORMALITIES OF THE KIDNEY AND URETER.

CONGENITAL ABNORMALITIES OF THE KIDNEY.

THE kidneys may be abnormal in respect to their form, their situation, and their number.

Changes in Form.—Variations in form are of least importance. The one usually seen is persistence of the fœtal lobulation to a greater or less degree. This may appear to be of no consequence, but the kidney is no exception to the general rule that a malformed organ is more easily affected by disease than a normal organ. Tuberculosis is frequently found in a malformed kidney.

Changes in Number.—An anomaly which is not very rare is the union of the two kidneys. This condition is characterized by the presence of at least two ureters. There must, of course, be a marked change in the form and position of the kidneys, for even though one kidney occupy its normal position and the other one is joined to it, there must be an absence of kidney on the other side. The commonest form of double kidney is the horseshoe kidney (ren arcuatus). The "arch" is almost always made by the union of the lower ends of the two kidneys in front of the vertebral column. This gives the double organ a crescentic shape with its concavity upward. The reverse position is sometimes seen. The renal pelves are directed forward, and both ureters and bloodvessels are frequently increased in number. The attachment of the two kidneys may be slight, or it may be so complete that only a fold shows where the two are joined. One kidney may be over-developed and the other one small. This anomaly is relatively frequent, being found once in about 1100 autopsies. (Figs. 85 and 86.)

A much rarer anomaly is a unilateral long kidney (ren elongatus). Both kidneys are then found on one side of the vertebral column, and the lower pole of the upper kidney is united to the upper pole of the lower one by a thinner or thicker mass of parenchymatous tissue. The pelves of the kidneys may be on the same side. In that case the ureter of the upper kidney passes to the opposite side of the bladder so that the ureters do not cross each other. The pelves of the kidney may be turned in opposite directions, giving an S shape to the whole organ. In this condition the ureter of the misplaced kidney crossed the abdominal vessels, the vertebral column, and the ureter of the other kidney.

The two kidneys may be united in a third form which has been compared to a shield (ren scutaneus). This form is the result of an

intimate fusion of both kidneys to a round, more or less flattened organ, which usually lies in the centre of the abdomen, rarely upon either side. There are generally two ureters. This type of abnormality may be looked upon as a horseshoe kidney with union of both

FIG. 85.

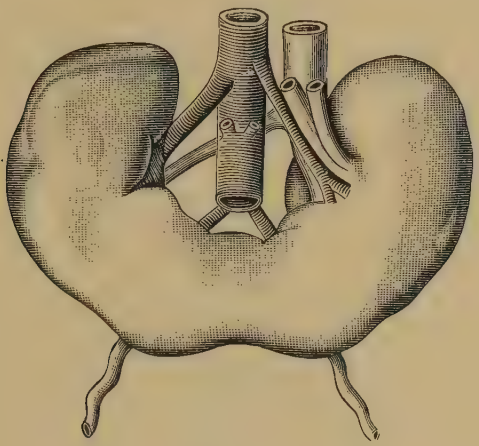
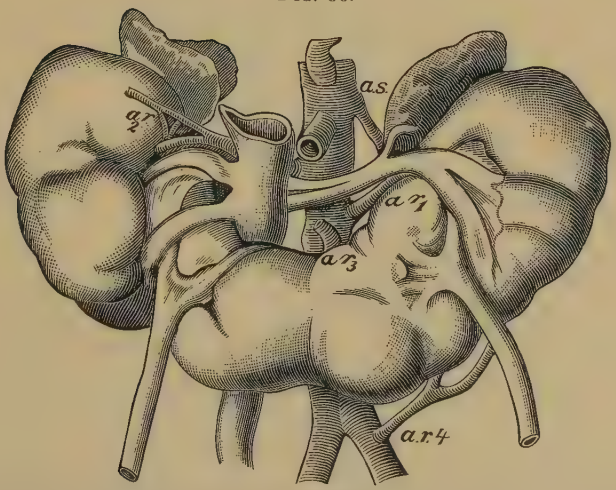


FIG. 86.



Horseshoe kidneys; one the usual form, the other an unusually large specimen with four well-developed renal arteries and veins: *a.s.*, art. suprarenalis; ar_1, ar_2, ar_3, renal arteries from aorta; ar_4, renal artery from common iliac. (Küster.)

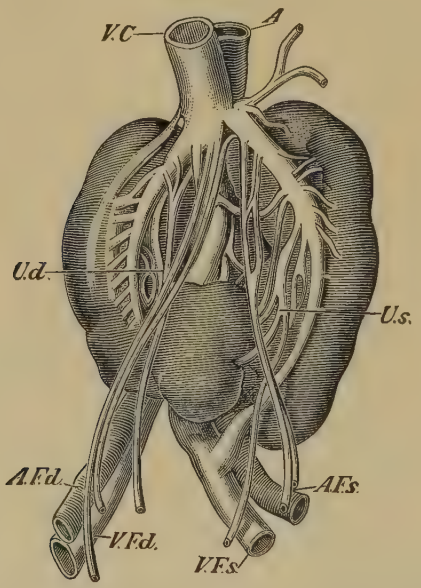
lopes and the posterior margins. The pelves form a groove in the centre of the anterior surface, from either side of which springs a ureter. The vena cava crosses a portion of the kidney while the aorta lies wholly behind it. (Fig. 87.)

An anomaly which possesses a far greater importance is the im-

perfect development of one kidney (hypoplasia renis) or its entire absence. A hypoplastic kidney may be of any size. It may be made up of fibrous tissue, with some rudimentary tubules and glomeruli, or it may contain a certain amount of well-formed parenchyma. There may be cysts in the connective tissue.

The ureter may be completely absent, or it may exist without a lumen, or it may be formed but abnormally small. It may be obliterated in places and pervious in places. The pelvis of the kidney may be absent or rudimentary. It is worth mention that the lower portion of the ureter may open naturally into the bladder, so that the passage of the ureteral catheter for a certain distance is no proof of the existence of an active kidney.

FIG. 87.



Partial amalgamation of the two kidneys: *A*, aorta; *V.C.*, vena cava; *AFd* and *AFs*, right and left femoral arteries; *VFd* and *VFs*, right and left femoral veins; *Ud* and *Us*, right and left ureters. (Küster.)

Defect of one kidney is frequently associated with defects or anomalies of the sexual organs. If one kidney is wanting, the suprarenal capsule may also be absent, but it is usually present. The single kidney which exists is usually normal in position and shape, but it may be malformed or misplaced.

Congenital failure of one kidney is not so very rare. According to Morris, it is observed once in 3370 autopsies. But its surgical importance is far greater than these figures would indicate, for the reason that in about one-half of the recorded cases of absence of one kidney the kidney which was present was so diseased as to be the cause of death. This explains why in the early days of nephrectomy there were

so many instances of removal of the diseased kidney followed by death of the patient on account of the absence of the other kidney.

The congenital absence of one kidney has about the same effect upon the other as the subsequent removal of one kidney by operation. That is, the single kidney which is present hypertrophies and reaches a size which is double, or perhaps triple, the size of a normal kidney. In rare cases the hypertrophy is very slight, or wanting. This point is also of great surgical importance, for if a surgeon cuts down upon a kidney with the intention of removing it, and finds that it is twice the normal size, he had better not proceed with the operation until he is absolutely convinced that the other kidney is present and performing its functions.

Changes in Position.—Changes in the position of the kidney (dystopia renis) give rise to diagnostic puzzles which are most difficult to solve. A congenitally misplaced kidney differs from a floating or wandering kidney in that it is firmly fixed in its position. If it is discovered accidentally or as a result of pain, it must be differentiated from a retroperitoneal tumor, from a tumor of the broad ligament, etc. Graser collected 200 instances of congenital misplacement. In 12 instances both kidneys were misplaced, while the left kidney alone was misplaced 103 times, and the right kidney alone 35 times. In one instance both kidneys were placed on the left side, and in 4 instances on the right side. The misplaced kidney was at the level of the promontory 22 times, and 15 times in the pelvis ; 10 times it was placed in front of the vertebral column. If a metallic probe can be passed into the ureter and a radiograph taken, an obscure diagnosis may become clear.

Hyperplasia of the kidney is far less common than the various defects of the kidney which have been mentioned. There are instances, however, of an increase in the number of the kidneys, or one kidney may be increased in size by the addition of a portion or the whole of a third kidney. Thus, Graser found in literature 13 cases of ren duplicatus, while in 2 instances four kidneys were present.

CONGENITAL ABNORMALITIES OF THE URETER.

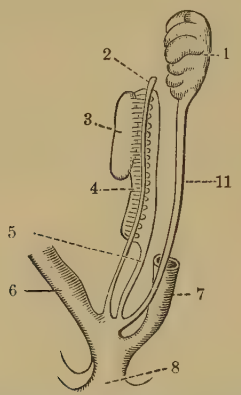
Congenital abnormalities of the ureter are partially dependent upon those of the kidney. In many other cases, however, the abnormality of the ureter affects not its upper end, but its lower one, and for the proper understanding of the conditions then present it is necessary to review the development of the ureters.

Before the kidneys are formed excretion is carried on by the Wolffian bodies. These are tubular glands whose transverse canals begin blindly but terminate in a common duct—the Wolffian duct—which leads into the lower end of the allantois. At a later period a sexual gland is formed on its inner margin, which ultimately develops into a testicle or ovary. (Fig. 88.)

Müller's duct lies to the outer side of this sexual organ. Its upper

end is also blunt. Its lower end opens into the allantois, near the opening of the Wolffian duct. If the sexual gland becomes a testicle,

FIG. 88.



Development of the urogenital tract at an early embryologic period: 1, kidney; 2, Müller's duct; 3, sexual gland; 4, Wolffian body; 5, Wolffian duct; 6, urachus (allantois); 7, rectum; 8, cloaca; 11, ureter. (Bock-Brass.)

FIG. 89.

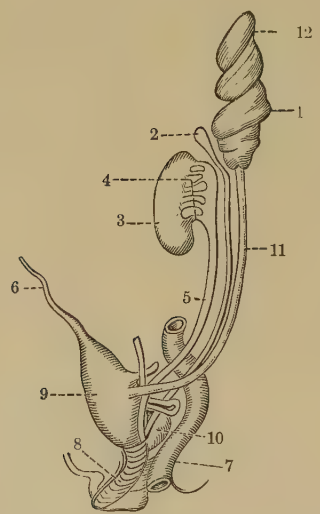
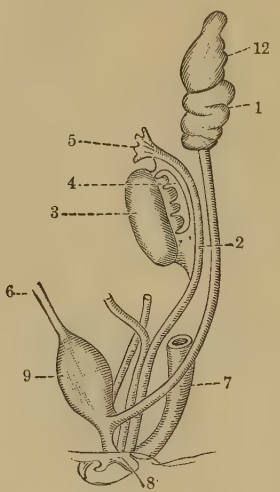


FIG. 90.



Development of the male urogenital tract. Development of the female urogenital tract. (Bock-Brass.)

1, kidney; 2, hydatid of Morgagni; 3, testicle (ovary); 4, vasa efferentia (parovarium); 5, vas deferens (Fallopian tube) (Wolffian duct); 6, urachus; 7, rectum; 8, sinus urogenitalis; 9, bladder; 10, uterus masculinus; 11, ureter; 12, suprarenal gland.

the upper portion of Müller's duct disappears, while the lower portion unites with that of the opposite side and persists as the vesicula pros-

tatica (uterus masculinus). From the Wolffian duct there develop the head of the epididymis, the vas deferens, the seminal vesicle, and the ejaculatory duct. (Fig. 89.)

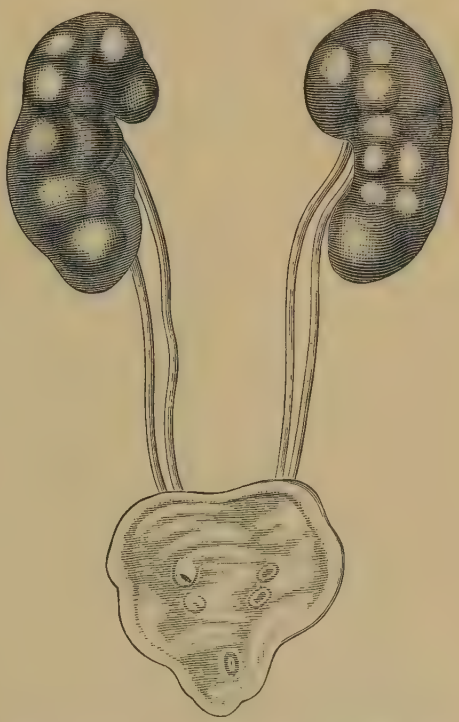
If the sexual gland becomes an ovary, the Wolffian duct disappears, except a very small portion, which is called the duct of Gärtner. The Fallopian tube is formed from the upper end of Müller's duct, while the uterus and vagina are formed by the union of the lower portion of the right and left ducts. (Fig. 90.)

The ureter is normally formed from a prolongation of the posterior wall of the lower end of the Wolffian duct. (Fig. 88.) It grows until it enters the previously formed kidney. At a later period the portion of

Fig. 91.

Cross-section of kidney with double pelvis and ureter. (Bayer.)

Fig. 92.



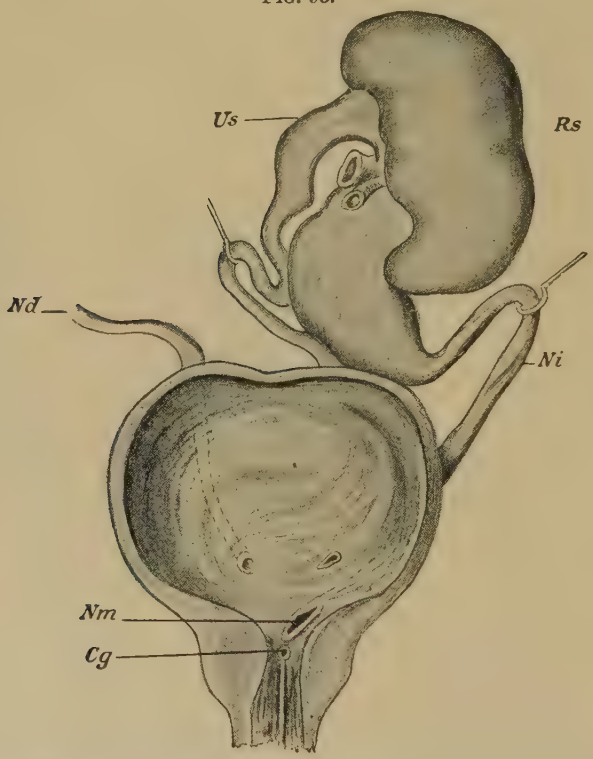
Kidney from an infant, showing four ureters, each with a separate opening into the bladder. (Bayer.)

the duct which is common to the ureter and the Wolffian duct becomes involved in the sinus urogenitalis, so that finally these two canals, the

true Wolffian duct and the ureter, end independently (Fig. 89) and at a constantly increasing distance from one another. If this process is uninterrupted and the mouth of the ureter is not carried upward as it normally should be, it will be found opening into the bladder near the sphincter, or in the male or female urethra, say in the vestibule of the vagina.

If the development is arrested at an earlier period, the ureter will not be separated from the Wolffian duct, and will therefore in a male open into the vas deferens, the seminal vesicles, or the ejaculatory duct, and in the female into the duct of Gärtner.

FIG. 93.



Double left ureters, *Us*, *Ni*, the latter opening low in the bladder, at *Nm*; *Nd*, right ureter; *Rs*, left kidney. (Civiale.)

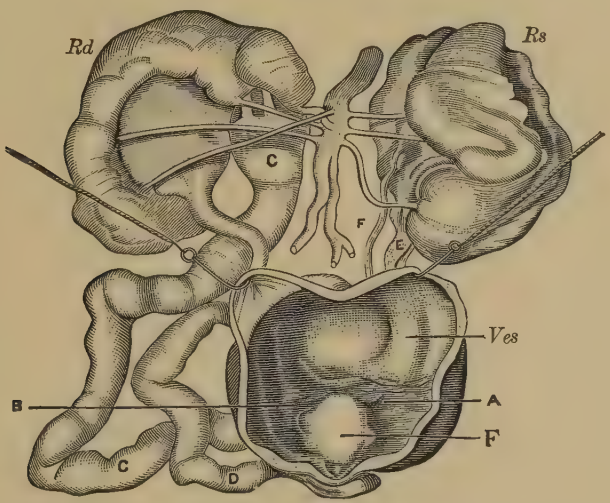
If the ureter separates from the Wolffian duct, but does not find an opening elsewhere, it will remain a blind passage. If, instead of opening into the anterior portion of the cloaca it opens into the posterior portion, it will ultimately be connected with the rectum, although this condition has never been observed in a fœtus capable of extra-uterine life. Abnormal communication of the ureter with Müller's duct causes it to empty into the vagina or uterus. A double ureter is

the result of double growth from the Wolffian duct or a division of a single growth.

The anomalies found in extra-uterine life are:

Double Ureter.—If the openings of the double ureter are normal, this anomaly has no pathological significance, consequently it is often overlooked. It is by no means uncommon, as is shown by the fact that Weigert observed seven cases in one year. In the great majority of cases each ureter starts in its own separate renal pelvis. The two pelves are separated in the hilus by a broad bridge of renal tissue. Such a kidney has its normal shape. When it is split open, it will be seen that its pyramidal portion is divided, while its cortical portion is not divided. If the ureters are distinct throughout, the one which

FIG. 94.



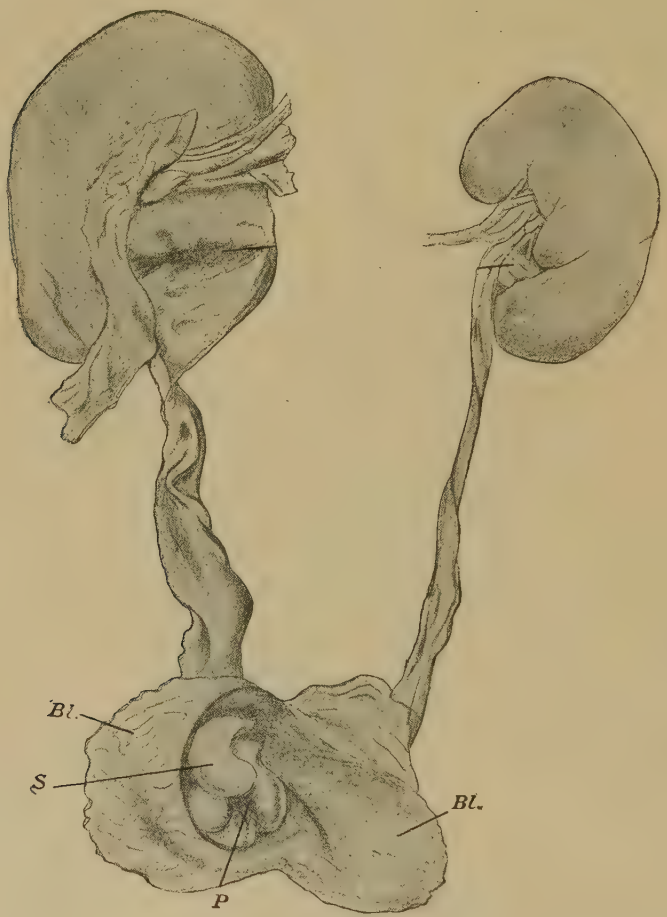
Double ureters—one dilated: *Rd*, right kidney; *Rs*, left kidney; *Ves*, bladder. The dilated right upper ureter, CC, terminates blindly in a cyst, F. The lower ureters, right D and left E, open into the bladder at B and A. F, the left upper ureter. (Boström.)

comes from the upper renal pelvis lies to the median side of the other and passes in front of or behind it in order to open into the bladder at a lower point. The two ureters may join and open into the bladder through a common tube. Double ureter is rarely found on both sides of the body.

Abnormal Ureteral Openings.—This condition is far more important than a simple double ureter. (Figs. 93 and 94.) The abnormal opening in man may be placed either in the region of the sphincter of the bladder, or in some other abnormal place, its mouth being abnormally small; or in the prostatic portion of the urethra, either behind the crest, or at its side, in which case the openings may be multiple and very small; or in the seminal vesicle, ejaculatory duct, or vas deferens.

The clinical condition will vary with the character of the anomaly. If the opening of the ureter is extremely small, or if it opens through muscular or contractile tissue—for example, through the sphincter of the bladder, or in the posterior end of the urethra, or in the seminal vesicle—the flow of urine will be interfered with, and there will result

FIG. 95.



Cystic dilatation of the lower end of the right ureter, *S*; *P*, middle lobe of prostate. (Englisch.)

dilatation of the ureter and of the pelvis of the kidney, and atrophy of the renal parenchyma. The ureter which opens abnormally is usually the upper one, and this portion of the kidney will usually be affected. This is not an invariable rule, as shown by Figs. 94 and 95. As the obstruction is never complete, the dilatation of the vessels is only moderate, and the pelvis of the kidney rarely exceeds in size that of

the closed fist. If the ureter terminates in the seminal vesicles, its effect is to dilate them. This condition is not associated with incontinence of urine so long as the musculature of the posterior urethra is sufficiently powerful to prevent it.

In women the extra ureter terminates either in the bladder or in the urethra, vagina, vestibule, or in the persisting Gärtner's duct. If the ureter opens in the urethra, it may pass through the wall of the bladder or cross the vault of the vagina. If there is no incontinence of urine, dilatation will result, or, at least, there will be dilatation of the lower end of the ureter. Even if the opening is in the pelvis, mechanical obstruction may be sufficient to produce dilatation.

In some cases, both in men and in women, an extra ureter or a single ureter may pass through the muscular wall of the bladder with a normal or dilated lumen and end in the mucous membrane either blindly or with a very fine opening. This may be due to epithelial adhesions. The portion of the ureter situated in the bladder-wall often undergoes cystic dilatation under such circumstances. (Figs. 94 and 95.) Such a cyst may be the size of a nut or very much larger. It may press upon the normal opening of the normal ureter of the same side and obstruct it, or, if it is large enough, it can also obstruct that of the opposite side. In this manner various degrees of unilateral or bilateral uronephrosis may result, as well as interference with the proper emptying of the bladder. This may lead to the development of calculi, cystitis, pyelitis, pyelonephritis, and death from uræmia.

If the cyst is large enough to reach the orifice of the urethra, or if it is situated in the urethra, it may greatly interfere with the passage of urine. The patient will then suffer not only from vesical tenesmus and irritation of the bladder, but also from a constant dripping of urine, or interruption of the stream, or complete retention. It is a curious fact that these symptoms have usually reached a higher degree in the female than in the male, and in consequence the females who have been affected have died in infancy or girlhood, while many of the males have lived to adult life.

Diagnosis.—Until the discovery of the cystoscope and endoscope it was practically impossible to make a diagnosis of these anomalies in the male. Interference with the passage of urine, vesical tenesmus, and pain on micturition are symptoms which may arise from so many causes that they would not of themselves lead to a correct diagnosis, while a moderate distention of the pelvis of the kidney could hardly be detected if looked for. Now by means of the cystoscope or endoscope the mouths of the ureters can be seen when normally or abnormally placed. It has already been mentioned that incontinence is not usually present, although the abnormal ureter opens into the prostatic urethra. If the opening is into the female urethra, incontinence is almost invariably present, because the muscles of the urethra are not sufficiently powerful to control the escape of urine. Therefore there are a constant dribbling of urine, and also from time to time normal

passage of urine from the bladder if the other ureter or ureters terminate there.

If a soft tumor covered with mucous membrane presses into the urethra, and if a sound can be passed around this tumor, or if it can be easily replaced by the finger, and its point of attachment is in the neighborhood of the mouth of the ureter, diagnosis can be made of a cystic intraparietal dilatation of the lower end of the ureter. If the tumor becomes somewhat tense when the patient stands up or otherwise increases the abdominal pressure, the diagnosis will be more certain. The endoscope will still further confirm the diagnosis.

Treatment.—Many of the conditions described are not amenable to treatment. Others have been relieved by one of the following operations:

1. Epicystotomy. A probe was passed through the opening of the ureter in the urethra up to the bladder. The bladder-wall was divided down to the probe, a section of the peripheral portion of the urethra was extirpated, and the wound cauterized. Another patient had two normal ureteral openings. Water injected into the third opening caused a cystic swelling in the neighborhood of the right ureteral opening. A portion of the cyst-wall was excised and the peripheral part of the ureter was ligated.

2. Dissection of the mouth of the ureter opening in the vagina and implantation of the same in the bladder.

3. Extraperitoneal exposure of the bladder and abnormal ureter by a suprapubic incision; division of the ureter and suture of its ventral end in the bladder.

4. Establishment of a communication between the ureter and the bladder and closure of the abnormal orifice. Wölfler gradually dilated a ureter which terminated in the vestibule until he was able to pass one blade of the instrument into it and the other into the bladder. The instrument was then closed, and as a result of the pressure an anastomosis was established between ureter and bladder.

5. Emmet lengthened a ureter which terminated high in the vagina, by dissecting and suturing a vaginal flap. He intended to implant this in the bladder, but the patient died of pneumonia.

The value of these different methods need not be here discussed, as the methods of causing a ureter to open into the bladder are considered in another place. Cystic dilatation of the portion of the ureter situated within the wall of the bladder is easily overcome. In the male epicystotomy should be performed and a portion of the cyst-wall removed. It is necessary to suture the ureter to the bladder. In the female a similar operation may be performed through the dilated urethra, or the sac may be opened through the endoscope.

CHAPTER XI.

INJURIES OF THE KIDNEY.

The kidney is so well protected by reason of its situation that it is seldom injured; and when it is injured, other organs are usually injured too, so that the damage to the kidney may not be the chief one. According to Küster's reckoning, there were only 10 cases of renal injury among 30,000 cases of disease and injury occurring in the Basle clinic, and only 1 of these was an open wound. Herzog found 16 spontaneous and 1 open injury of the kidney in 7805 autopsies. In time of war, injuries of the kidney, especially those in which there is an open wound, are much more frequent. But although this injury is of such rare occurrence, its gravity is great, and therefore it is one which should be carefully considered.

INJURY OF THE KIDNEY WITHOUT AN OPEN WOUND.

This lesion is one which was formerly little spoken of, so that Maas in 1878 was able to collect only 71 cases. Of late years more attention has been paid to it, and in 1896 Küster collected records of 306 cases, 241 of which were free from other complications. He says that injuries of the right kidney are more frequent than those of the left. They are not wholly absent from the first ten years of life, but are most frequent in the second and third decades. After that they are again more rare. This relative frequency corresponds, of course, to the frequency with which persons of different ages are exposed to injury. No less than 94 per cent. of the recorded cases occurred in men, and only 6 per cent. in women. This difference, though less marked in childhood, is even then a striking one, since of the 41 patients under fifteen years who suffered from an injury of the kidney, 80 per cent. were boys. It hardly seems possible that this condition can be wholly due to a difference in occupation and to the greater wildness and recklessness characteristic of boys and men. Küster believes that the structure of the female body, with its broader iliac crest and thicker layer of fat, affords the kidney greater protection, and that the female dress is often such as still further to protect the kidney from serious injury.

The kidney may be injured in various ways, though it is often difficult to make out exactly how an injury occurs. If a blow is received in the lumbar region either from in front, or from the side, or

from behind, or if the body is crushed between moving objects or run over, the mechanism of the injury is clear enough. But there are other cases in which the kidney is injured by force applied to the body at a distance from the kidney. There are also rare cases in which the kidney is seriously injured by severe muscular exertion due to lifting a heavy weight, jumping, or performing gymnastic exercises.

Rayer and Tuffier explain the injury to the kidney following blows upon some other portion of the body as due to the jarring thereby caused. Le Dentu ascribes it to contrecoup similar in nature to the injury which the brain suffers from a blow on the opposite side of the skull. Naturally any sort of bodily injury which throws the kidney violently against the transverse processes of the vertebræ can injure the organ. Güterbock was of the opinion that in many injuries the force squeezes the poles of the kidney together and thus has a tendency to produce transverse fissures.

Küster has recently spoken of hydraulic pressure as a cause of renal injury. He arrived at this conclusion as the result of experiment. If a kidney, recently removed from an animal, is thrown with force upon the floor, its parenchyma will show the effect of the violence. After the capsule has been removed, it will be seen that the portion of the kidney which came into contact with the floor is flattened and separated from the surrounding tissue by a circular or half-circular tear. Within this area the parenchyma is superficially bruised and contains many slight tears. If the veins of the kidney are first ligated and the artery is distended and ligated, and the pelvis is distended, and the ureter ligated, the result of throwing the kidney violently against the floor is quite different. Instead of the slight circular tear there will be found a deep tear, and a deep bruise instead of a superficial one, and other deep tears extending into the renal pelvis. Sometimes the edges of the tear gape open so that the pelvic fat may protrude. It has been shown that the lower ribs of the left side can be pressed against the kidney by a moderate amount of force, and if the vessels and ureter are distended and then ligated, a blow with a wooden mallet will easily suffice to produce a rupture in the kidney which may extend to its anterior as well as to its posterior surface.

The most natural explanation of these facts is that the force which was applied at the side of the body presses the movable ribs against the distended kidney and thus causes the latter to rupture. If the blow is received from in front, the injury is probably due to very energetic contraction of the diaphragm and other muscles. It hardly needs mention that other forces working tangentially or more slowly may produce injuries of the organ not to be ascribed to hydraulic pressure.

Character of Injury.—The injuries which a kidney may receive are conveniently divided into five classes:

1. The fatty capsule and the fibrous capsule may be injured without

damage being done to the parenchyma. The result is usually an effusion of blood between the kidney and the fatty capsule, or infiltration of the fatty capsule with blood. The later result is a connective-tissue induration, or the change of a large blood-clot into a cyst.

2. The parenchyma may suffer a contusion associated with hemorrhage into the tissue, even though no rupture of its substance is visible. At other times there will be slight transverse, radiating, or star-shaped tears which do not puncture the renal pelvis. Such an injury does not produce severe symptoms, and is usually seen only at autopsy after death has been caused by some other and more serious injury. (Fig. 96.)

3. The tear, or tears, in the kidney may penetrate the renal pelvis. They may be traced transversely or obliquely, or they may radiate from a certain point. Such a fissure may separate the organ transversely into two portions, or, in very rare instances, it may split it longitudinally. The hemorrhage is then much more serious. It may

FIG. 96.

Typical rupture of the kidney, with deep and shallow fissures. (Güterbock.)

infiltrate the surrounding tissues and extend into the fatty capsule, into the retroperitoneal tissue, along the large intestine, into the mesentery and the small intestine, along the spermatic cord to the inguinal ring, into the scrotum or the labiæ, into the pelvis, or into the abdominal wall. Such a hemorrhage may be of itself dangerous to life, or it may block the ureter, or fill the bladder with blood-clots, causing the urine to accumulate in the neighborhood of the kidney, usually behind the fatty capsule, and giving rise to a large fluctuating tumor, and ultimately to gangrenous perinephritic abscess or diffuse infiltration of

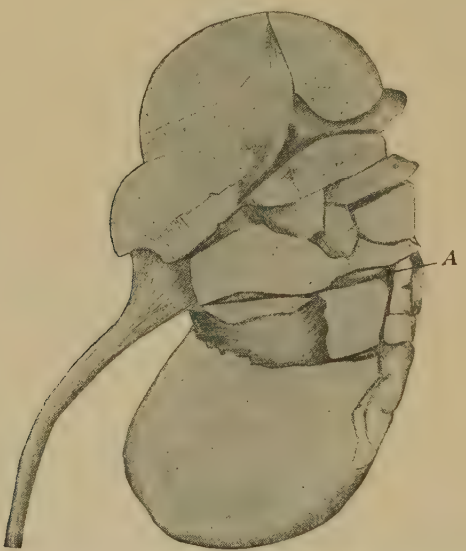
urine, suppuration in the kidney, etc. This suppuration may loosen the thrombi and produce secondary and often fatal hemorrhage.

4. The kidney may be crushed to bits, as is represented in Fig. 98. Under such circumstances large sections of the kidney may be wholly separated from their blood-supply. If such a patient does not die from primary or secondary hemorrhage, he will succumb to the gangrene which must necessarily follow.

5. There may be perirenal injury, such as rupture of the renal vessels or of the ureter, or of the whole hilus. The results of such an injury are naturally severe. There may be quick death from hemorrhage, or necrosis of the whole kidney or a considerable portion of it, extensive infiltration of urine, with gangrene, or general sepsis.

Often the patient suffers from injury of other organs, such as fracture of the ribs, rupture of the peritoneum, injuries of the intestine, or liver, or spleen, etc.

FIG. 97.



Rupture of the left kidney of a man aged eighteen, caused by a fall from a height. (Güterbock.)

Symptoms.—The symptoms due to injuries of the kidney are often masked by severe shock, which comes on almost immediately and may last for an hour or for many hours. It is difficult to say whether this shock is due to the injury of the kidney or whether it is due to the injuries of other tissues which invariably accompany it. Thus the shock may be due to tearing of the peritoneum, or hemorrhage into the peritoneal cavity, or contusion or jarring of the solar plexus, or to a jarring of the brain. This question is the more pertinent since there are instances in which a patient whose kidney has been severely

wounded has walked for a considerable distance, or continued his work until gradually increasing anæmia, due to internal hemorrhage, has made this impossible. What is true of shock is to a certain extent true of such other symptoms as vomiting, hiccough, nausea, and meteorism.

The pain may be extreme, or it may be slight, or, being slight at first, it may gradually increase. This increasing pain is apparently due to the gradually increasing tension and tearing of the parts, which are the result of continuing hemorrhage or urinary obstruction, or it may be due to the passage of blood-clots through the ureter. If the pain originates in the ureter or is due to stretching of the capsule of the kidney, it will be referred not only to the lumbar region, but also to the testicle or to the thigh. Such reference of pain to a distant part may also be due to an extravasation of blood along the course of the sensory nerves, such as the ilio-inguinal or genitocrural.

Very intense pain immediately after the injury may perhaps be due to the crushing of the parenchyma as well as to the stretching of the capsule. The pain may also be due to injury of the surrounding soft parts and bones.

There may or may not exist such external signs of injury as cutaneous erosions, ecchymoses, and local swellings. Such injuries of the skin are often of help in determining the character of the blow and its probable effects. A slowly developing, more or less circumscribed tumor in the lumbar region is significant of a collection of blood or urine in the renal pelvis or within the fatty capsule. Such a condition may be hæmonephrosis or hæmo-uronephrosis, or traumatic pseudo-uronephrosis, or in rare cases a true traumatic uronephrosis if the injury has kinked or otherwise obstructed the ureter, and has caused the urine to distend the unruptured renal pelvis.

Effusion of blood or muscular contusion may lead to flexion of the thigh. The effused blood may work down behind the peritoneum and some days later appear in the inguinal region, or along Poupart's ligament, or at the root of the penis or elsewhere.

One of the most important symptoms of renal injury is the appearance of blood in the urine—that is, hæmaturia. It is often absent both in the slight injuries in which the tear in the kidney does reach its pelvis and in severe injuries in which the ureter is torn. But in the large majority of severe injuries of the kidney hæmaturia is present. The character of the hemorrhage is variable. If the blood is small in amount and has time to coagulate in the pelvis of the kidney or ureter before it passes into the bladder, some hours may elapse after the injury before the blood appears in the urine, and the quantity may even then be very small. When the worm-like blood-clots which are formed in the ureter pass to the bladder, they cause intense pain similar to that caused by the passage of a renal calculus. The passage of a blood-clot through the urethra may also cause the patient intense pain.

If the hemorrhage is larger in amount, the blood flows quickly through the ureter and mixes with the urine already in the bladder and excites a desire to urinate, with the result that the patient passes urine which appears to be pure blood.

If the bladder is empty and the blood flows into it rather slowly, it may coagulate wholly or in part in the bladder. As a result the patient may succeed after great straining in passing merely a few drops of bloody urine and fragments of blood-clot; or if the blood coagulates completely in the bladder, he may not be able to pass any fluid through the urethra. Under such circumstances it is necessary to break up the clot by means of a good-sized catheter having a large eye, and repeated short irrigations. Pressure made by the hand placed above the symphysis will aid in this manœuvre, which is at best a tedious one, though absolutely necessary.

Sometimes the bleeding is so slight that these severe symptoms do not arise. There is so little blood in the urine that it cannot clot, but merely stains the urine red. If the shade is reddish brown, it is an indication that the quantity of blood mixed with the urine is slight, and that the urine has acted upon it for a considerable time. Renal hemorrhage may be differentiated from vesical hemorrhage by the fact that the first and last urine passed from the urethra contains an equal amount of blood, while in vesical hemorrhage the last urine passed contains a good deal more blood than that passed first. Furthermore, if the hemorrhage is from the urinary vessels above the bladder, the irrigating fluid will return clear for a time if the bladder can be washed clean. If the hemorrhage is from the bladder, the fluid is constantly mixed with blood. This is, however, an uncertain method of differentiation, and is far inferior to cystoscopy, provided the vesical contents can be sufficiently cleared by irrigation to make this possible.

Hemorrhage from the kidney is also marked by the appearance in the ureter of cylindrical clots corresponding to the lumen of the ureter, by the excretion of fluid which looks like water in which meat has been washed, and by urinary casts. Urine which contains blood must also contain a certain amount of albumin. A traumatic nephritis often follows traumatic hæmaturia of renal origin, so that after the hemorrhage ceases the urine will be for a few days free from albumin and casts. Then there will appear a great number of larger and smaller casts more or less covered with epithelial cells and granules, and the urine will again contain albumin. At this time there is often polyuria, which is a further indication of an interstitial inflammation.

Recent investigations show that hæmaturia may follow very slight injuries of the kidney, so slight as the manipulation of renal palpation. Routine examination of the urine before and after such palpation will reveal the presence of blood and albumin due to palpation in more than half of the cases. (Menge.) Edlefsen calls attention to the albuminuria which may follow traumatism without hæmaturia.

As the injury of the kidney may consist in a complete division of

the organ, or crushing, or tearing away of the whole kidney, the hemorrhage may easily threaten life. The collapse which occurs immediately after a severe injury of a kidney passes gradually away, while a hemorrhage brings about a weakness which increases more or less rapidly, and an anæmia which becomes more and more marked. If the blood flows directly into the bladder, the enormous quantity which is evacuated will give some idea of the extent of the hemorrhage; but if the ureter is torn or displaced, the hemorrhage may take place internally, and can then only be recognized by the progressing anæmia and the presence of an increasing tumor, which may be soft or hard, sharply limited or diffuse. If the peritoneum is torn and the blood flows directly into the peritoneal cavity, its presence will be manifest by an increased area of dulness in the lower portions. In any of these conditions death from hemorrhage may occur in a short time. Between this extreme and the other of a slight admixture of blood in the urine, which passes off in a day or two, there are all possible degrees. It is by no means uncommon for secondary hemorrhage to follow an injury of the kidney. This is due to the influence of the urine in softening thrombi, aided, perhaps, by suppuration or gangrene. Such secondary hemorrhage may in a moment so change the whole outlook that an injury from which the patient has apparently almost recovered may speedily become fatal.

Another early consequence of renal injury is anuria, or oliguria. Fortunately, in its extreme degree this is not a common symptom. It is evident that the kidney which is badly injured will not be able to excrete its normal amount of urine, but if some parenchyma and vessels are preserved, and the blood-pressure does not sink too low, its function will not be wholly suspended. Whether its urinary product finds its way into the bladder or into the perirenal tissue will depend upon the nature of the injury. Under certain circumstances, however, no urine nor pus from the injured kidney can flow either into the bladder or into the perirenal tissue. If the kidney happens to be a solitary one, or if its fellow is rudimentary or destroyed by disease or by accident, the anuria may be total. Total anuria may also result in another manner. It has already been mentioned that excretion from a kidney is sometimes suspended on account of reflex influence exerted by its fellow. Such a reflex anuria is seen most often in connection with calculi in the pelvis of the kidney and impaction of a calculus in the ureter. This is spoken of at length in the section devoted to these subjects. Reflex anuria is also seen as the result of injury, so that instead of the uninjured kidney performing the work of both, as is usually the case, it may suspend entirely its function of excretion and possibly never resume it. The explanation of this peculiar fact is given by Masius. He says there are fibres in both the vagus and the splanchnic nerves which tend to contract the renal vessels, and the irritation of which suspends completely the excretion of urine. He found that irritation of the peripheral stump of either vagus in the neck stopped

the excretion of urine from both kidneys. If such irritation is kept up for a considerable time, death will follow, because the renal epithelium will be seriously injured.

If the excreting function of the injured kidney is suspended, the result will be an oliguria whether the opposite kidney is affected by resex action or not. Even though the opposite kidney proves itself ready to take up the work of the injured one, this can only be done after a certain time has elapsed, and the quantity of urine excreted depends in great measure upon the distention of the renal vessels; and if the blood-pressure is low as the result of severe hemorrhage, it is not to be wondered at that some days are necessary before the healthy kidney can do the work of two.

A third cause of death after injury of the kidney is the degeneration which follows the escape of urine into the surrounding tissues. The destruction of tissue which follows the escape of urine from the urethra after perineal injuries is well known. It is true that a considerable quantity of unchanged, acid, healthy urine can be borne by the tissues without special injury, and it will be resorbed from them. But this resorption is only possible within certain narrow limits, and any fermentation of the urine at once puts an end to its harmlessness. The force with which the urine passes into the perirenal or retroperitoneal tissues after an injury of the kidney is far less than that with which it is forced into the tissues from a ruptured urethra. Thus it is possible that the infiltration of urine may be held in check by the inflammatory reaction which follows traumatism, and the collection of urine in the tissues thereby limited. If such is the case and suppuration develops later, a prompt operation may bring equally prompt relief. Extravasated urine affords an excellent field for the growth of bacteria, especially if the hemorrhage makes it necessary to insert a catheter one or many times. Even with the greatest care bacteria may thus be brought into the bladder; and once the bladder is infected, the infection will readily spread to the area of traumatism. In other cases it may well be supposed that microbes which are circulating in the blood set up fermentation in the extravasated urine. In still other cases the organisms of degeneration seem to come from the colon or some other portion of the intestine which has been simultaneously injured. An intestinal wall which is inflamed no longer imposes an impassable barrier to the bacteria in its lumen. In some cases bacteria enter through wounds in the external skin.

If the peritoneum is torn so that there is open communication between the infected traumatic area and the peritoneal cavity, gangrenous peritonitis and death will speedily follow. Even without such complication, gangrene or suppuration of the kidney and its environments may seriously threaten life. The infection may pass down the ureter to the bladder and then extend to the other kidney, and thus produce death. Or, the peritoneal tissue may become infected and the subdiaphragmatic suppuration may extend to the pleura either by con-

tinuity or by bursting through the diaphragm. Various after-effects may be felt though the patient recovers: thus suppuration may continue and give rise to a permanent fistula, or the kidney may atrophy, being imbedded in scar-tissue, or a parenchymatous or interstitial nephritis may persist. Displacement of the kidney, or kinking or stricture of the ureter may be the direct result of a traumatism, or may develop later on account of cicatricial contraction. These alterations may in turn lead to primary or secondary traumatic uronephrosis. A blood-clot may form the nucleus of a calculus in the kidney or in its pelvis, and the injury of the kidney may lead to the development of a malignant growth.

Animals often survive rupture of the kidney and discharge of urine into the peritoneal cavity. Even in man this accident does not invariably produce peritonitis, and most of the deaths following it are from other causes. Petroff cites 14 cases: in 1 the patient recovered; 2 patients died after operation, 8 others died within two days of hemorrhage or shock, 1 in four days of possibly localized peritonitis, and 1 only of clearly infectious peritonitis set up by the urine discharged into the peritoneal cavity. Quervain treated a patient by laparotomy, suture of the peritoneum over the kidney, and tamponade. He recovered, but Quervain believes he might have done so without an operation.

Tuffier says that wounds of the renal parenchyma discharge very little urine. At the present time it must be admitted that we do not know how extensive wounds of the kidney with peritoneal tears may be recovered from spontaneously.

Diagnosis.—From the symptoms which have been given above, one will usually be able to establish a diagnosis if the kidney is severely injured. Slight injuries may be easily overlooked, but this mistake is unimportant. It is desirable for the sake of prognosis and treatment not simply to recognize a severe renal injury, but to determine the character of such injury, and the presence of complications in other organs, so as to protect the patient against the harm which may come from admixture of blood with the urine, or from interstitial hemorrhage, or from infiltration of urine, or from retention of urine, or from gangrene and suppuration, or from anuria and oliguria. The surgeon should also endeavor to learn whether the kidney which has been injured was previously healthy, whether one or both kidneys are injured, and whether the uninjured kidney is healthy. In order satisfactorily to answer these questions it is desirable to palpate the lumbar region thoroughly, though with great caution, to possess exact knowledge in regard to the quantity and quality of the affected urine, and the course of the temperature, etc., and in certain cases to use an aspirating-needle. This method of examination finds its best use immediately before an exploratory operation.

Diagnosis of coexisting injury of the peritoneum may be very difficult. If the force has been applied from behind the body, the

peritoneum is less likely to have been injured. If the pulse and temperature gradually rise and tenderness spreads throughout the abdomen, there is probably peritoneal involvement. Free fluid in the peritoneal cavity makes the diagnosis certain. Meteorism, especially of the neighboring colon, may be due to traumatic paralysis of the bowel.

Prognosis.—Statistics collected by Maas and Küster show a mortality of 47 per cent. after injury of the kidney (144 deaths in 306 cases). The mortality is much less if one excludes those cases in which there was a complicating injury of some other organ of severe character, such as injury of the brain or spinal cord, or of the lungs or pleura, or of the peritoneum, or of some abdominal organ, or of the bladder, or of the other kidney, or a complicated fracture. There were 84 such cases, with a mortality of 92 per cent. Subtracting these, there remain 222 cases of uncomplicated renal injury, with a mortality of 30 per cent. In round numbers, therefore, one-half of the patients with severe injury of the kidney recovered, while two-thirds of those patients recovered who had suffered an injury of the kidney without serious complication.

Of a total of 67 deaths, 10 occurred the first day, 13 others in the first week, 21 others in the first two weeks. The causes of death were: shock, 5 times; hemorrhage, 30 times; suppuration, 27 times; chronic nephritis, 3 times; calculus and œdema of the lungs, 2 times.

Shock may be immediate, or it may be delayed a few hours. Hemorrhage may also prove fatal at once or in the course of a day, or it may occur and possibly prove fatal several days afterward, perhaps from rupture of a traumatic aneurism.

Treatment.—The threatening symptoms of shock and hemorrhage require immediate attention. The patient should be kept absolutely quiet, with the head low. Morphine should be given to control the pain, while ice should be applied in the region of the kidney to limit the hemorrhage. Stimulants should be administered with great caution, even though there is collapse, lest they increase the flow of blood. Any means which raises the blood-pressure may appear to do good by reducing the cerebral anæmia, but may increase the loss of blood, and thus do far more harm than good. On the other hand, fainting and absolute quiet reduce the blood-pressure, and favor the formation of thrombi in the injured vessels. Therefore shock which lasts an hour, and during this period reduces to the minimum the blood-pressure, may save the patient from a fatal hemorrhage. In many cases it is remarkable how little blood is lost in spite of the size of the vessel which is damaged. Unfortunately this is not always the case. Sometimes the bleeding continues, and although the bladder is frequently emptied, it fills again with bloody fluid; while a constantly increasing tumor in the loin, a pulse growing steadily smaller and weaker, and a deepening pallor, make it evident that death will occur in a short time unless the hemorrhage can be checked. Such relief can, of course, only be afforded by exposure of the injured vessel and

its ligation or compression. This principle of treatment seems plain, but it is only in recent times that it has been followed. The first nephrectomy on account of continued hemorrhage was performed in 1883, by Rowdon, seventeen days after the injury. This patient died from suppuration in the other kidney. In 1886 Arx operated twenty days after the injury, and also lost his patient. In 1889 Studsgard operated forty-eight hours after the injury and succeeded in saving the patient. Since that time many other surgeons have saved patients by prompt operation.

At first surgeons had no thought to save a patient from fatal hemorrhage except by removing the injured kidney, but in 1891 Küster and Keetley showed that under certain circumstances exposure and tamponing of the renal wound or the renal pelvis will suffice to stop the renal hemorrhage, while saving the kidney. This plan of procedure has also been followed many times with success, and while it is doubtless true that failures by this method as well as by extirpation of the kidney are not always reported, still both of these operations are of such a character as to merit commendation under proper circumstances. Indeed, the indication is now so clear that when hemorrhage after injury continues for a few hours, it is the duty of the surgeon to expose its origin. If the peritoneum is probably uninjured, the kidney should be cut down upon through an incision in the loin. If there is reason to suppose that the peritoneum is ruptured so that blood and possibly urine enter freely into its cavity, the transperitoneal method is preferable. At least two patients have recovered after operation, although a severe injury of the kidney was complicated with tearing of the peritoneum. Küster points out that the transperitoneal method is not adapted to conservative procedures and compels the surgeon to prefer nephrectomy; and, further, that it does not provide for drainage of the retroperitoneal space. He prefers a transverse lumbar incision, cleansing and suturing the peritoneum through this incision after other abdominal organs which may have been injured have been attended to.

The difficulty of the operation begins after the muscular planes have been divided and one approaches the source of the hemorrhage. It is a safe rule to expose the parts widely in order to obtain a clear view of the whole region, and to decide promptly how the hemorrhage had best be controlled. In one case it may be best to empty quickly the large wound cavity in order to expose the fragments of kidney and the torn fatty capsule which lie at the bottom of the wound, while in another case it may be necessary to divide the intact fibrous capsule before arriving at the bleeding vessels, while in still a third case the kidney may appear uninjured until the hilus is reached. The surgeon must decide whether the bleeding vessel should be clamped or compressed with a sponge, or by his finger, until everything is made ready for its permanent compression or ligation, or for ligation of the renal artery.

If it is necessary to tie the renal artery, the kidney will thereby become a useless organ, and had better be removed. If a portion of the kidney—for example, one of its poles—is torn away from the body of the organ, while the main portion is well supplied with vessels, the lesser portion should be removed and the hemorrhage controlled by clamps or suture, or tamponade. If the kidney is split transversely or longitudinally, hemorrhage may sometimes be stopped by a deep suture. If no rent in the kidney is found, the pelvis of the organ may be opened, emptied of blood-clots, and tamponed or sutured to the skin.

In most cases, however, the hemorrhage is not such as to make an immediate nephrectomy necessary. Usually the bleeding is moderate in amount, though it may continue for days or weeks until the progressing anæmia makes an operation advisable. Under such circumstances one is apt to postpone operation in the hope that a hemorrhage may stop of itself. It should not be forgotten that the proper time for intervention can easily be passed, and that there is a certain risk of secondary hemorrhage which may cost the patient his life unless by prompt operation at the time of its occurrence the surgeon is fortunate enough to avert this disaster. Such a secondary hemorrhage may occur some time after the primary bleeding has ceased. Therefore, during the first two or three weeks, if operation is not decided upon, all the means should be at hand for an immediate operation should this become necessary.

It sometimes happens that a patient is much disturbed by a symptom whose import is for good rather than for evil. After the urine has been clear for a considerable time it again suddenly becomes stained brownish red from an admixture, not of fresh blood, but of old, partly degenerated blood. This is due to the bursting into the urinary stream of some collection of blood and urine. This symptom is usually accompanied by a decrease in a persistent swelling in the lumbar region.

If the bladder is filled with blood-clots and the urethra is of normal calibre, the clots may be removed by a silver catheter and repeated irrigation, as mentioned on page 234. If there is stricture of the urethra, or if the patient is a child, it may be necessary to perform a cystotomy in order to remove the clots. So far as known, this operation has never been performed with success. Rowdon removed the injured kidney of a boy aged twelve. Four days later he opened the bladder by a lateral perineal incision and removed the blood-clots, but lost his patient nineteen days afterward from suppuration of the remaining kidney.

Statistics show that many patients have died from suppuration of the injured kidney and of the tissues in its neighborhood, but they also show that such an unfortunate termination may often be avoided by proper surgical procedures even after the suppuration is well developed. Such an operation does not present the difficulties of a nephrectomy for hemorrhage, and the surgeon can proceed slowly and carefully. It will

usually not be practical to save any portion of the kidney. It is far more important to avoid infection of the other kidney, and hence extirpation of the injured and suppurating kidney is demanded whenever an increasing tumor in the lumbar region, fever, and aspiration of fluid show that there has been an extravasation of urine which has been followed by sepsis or gangrene. Link attempted to save one-half of the kidney by removing the lower necrotic portion, but the discharge of urine from the wound was thereby increased and the general condition of the patient was made worse, so that it was necessary to extirpate the remainder of the kidney eleven days later.

OPEN WOUNDS OF THE KIDNEY.

Open wounds of the kidney are rarer than subcutaneous wounds, since most of the injuries of the kidney are due to indirect violence. Gunshot-wounds, stab-wounds, and in rare instances incised wounds, may extend to and injure the kidney.

Stab-wounds and Incised Wounds.—These injuries of the kidney are of rare occurrence. Küster was able in 1896 to collect from medical literature records of 43 cases. The location of the wound and its direction may excite suspicion that the kidney has been injured. The diagnosis will be confirmed by the appearance of blood in the urine, or the flow of urine from the wound. The diagnosis might possibly be erroneous in case the ureter was injured. The absence of these two symptoms is no proof that the kidney is uninjured. The presence of both of them at the same time is an indication that the wound extends to the renal pelvis.

If the wound in the soft parts around the kidney is very extensive, the kidney may prolapse, since its slight attachments permit it to be displaced by coughing or other contraction of the diaphragm and abdominal muscles. It may also appear in the wound immediately after the injury and remain there like a hernia. Under such circumstances the edges of the wound will grasp the edges of the kidney, and the subsequent symptoms will be more or less severe according to the firmness of this grasp. If only the venous flow of blood is obstructed, the kidney will become bluish red, and will swell and bleed profusely from any wound in its substance. If the condition is not relieved, there is danger of thrombosis and finally gangrene. Five such cases are recorded in literature, showing that the accident is relatively common in cases in which the wound reached the kidney below the ribs. Prolapse of the kidney is, of course, impossible if the organ is injured through an interstitial space. Küster is of the opinion that the majority of lumbar wounds if of sufficient length produce a prolapse of the kidney.

The kidney should, of course, be replaced and fixed in its normal position by tampons, or, if circumstances permit, by suture. The pain caused by prolapse of the kidney into a wound is remarkably slight,

and can usually be explained by the presence of a wound in the skin and soft parts. This shows that the intense pain which sometimes follows subcutaneous renal injury is not due to the injury itself, but rather to complicating injuries, or to a stretching of the renal capsule. The cremasteric cramp described by the older writers as characteristic of injury of the kidney apparently only occurs when blood-clots pass through the ureter.

Simple wounds of the kidney will usually heal by first intention. The healing of an open wound of the kidney is therefore dependent on the presence or absence of complications, and the presence or absence of suppuration. If the wound is infected, perinephritis and suppurative nephritis may easily develop, and will require proper treatment.

Stab-wounds of the kidney are possibly complicated with those of the pleura and lung, or of the peritoneum and intestine. These complications will require their own special treatment.

An open wound of the kidney requires various treatment according to circumstances. If the kidney is exposed and incised by a long skin-cut, and the patient is seen soon after the accident, it is proper to suture not only the kidney, but also at least a portion of the wound in the soft parts. If, on the other hand, there is a narrow stab-wound, and injury of other organs is suspected; or if the presence of blood in the urine or the flow of urine from the wound points to a deep wound in the kidney, the surface wound should be drained, not sutured. In all such cases free access to the kidney should be preserved even though to secure this it is necessary to enlarge the external wound. This is the treatment for a lumbar wound.

If the kidney has been wounded through an interstitial space and the pleura, a lumbar incision should be made, and the wound in the kidney drained through it with iodoform gauze.

If there is free discharge of blood and urine from the external wound, the kidney must be exposed and the hemorrhage controlled by suture or tamponade according to the condition and age of the renal wound. If the hemorrhage cannot be controlled in this manner, a large artery has probably been injured. If one can stop the bleeding by artery-clamps, it may be possible to save the kidney. In doubtful cases Küster advises that the clamps be left in position twenty-four or forty-eight hours, during which time the wound in the kidney is tamponed. If at the end of this period the hemorrhage has stopped, and the circulation in the kidney is good, as shown by its bleeding when pricked with a needle, the clamps can be removed and the wound tamponed. If the kidney does not bleed when pricked, it must be extirpated.

Gunshot-wounds.—Usually the lung, liver, spleen, intestine, pancreas, or some other organ or organs is also injured by the shot which injured the kidney.

The older writers upon military surgery have nothing to say in

regard to gunshot-wound of the kidney. In the report of the American War of the Rebellion, Otis describes 85 cases, with 69.41 per cent. of mortality, and there are 15 cases described as occurring in the Franco-Prussian War, with 53.33 per cent. of mortality. Some 29 cases have been reported in literature as occurring in times of peace, with 28.41 per cent. of mortality.

The relatively tense tissues of the kidney cause it to suffer extremely when struck by a bullet of high velocity. Küster's experiments showed the effect of this hydraulic pressure very beautifully. When a kidney which contains no blood is shot, the bullet simply passes through it; but if the vessels and pelvis of the kidney are distended with fluid, it bursts to pieces when struck by a bullet of high velocity.

The gunshot-wound of the kidney may be slight in extent or it may be severe. If the injury is confined to the cortex, so that neither the large vessels nor the pelvis is injured, the symptoms will be slight. Even if the pelvis is perforated, without other injury of the organ, the patient may recover after a hæmaturia lasting for several days. The cauterization of the wound produced by the missile protects the patient to a certain extent against infiltration of urine.

The injury is far more serious if a large vessel is ruptured and the peritoneum is opened, even though no other abdominal organ be injured. Patients with such injury have several times been operated upon by laparotomy, and the blood-clots have been removed and the kidney extirpated. Some of them recovered, while others died from various causes.

Gunshot-wounds are distinguished from others in that the bullet often carries with it into the tissues fragments of clothing which are pretty certain to infect the wound. If on this account the kidney or the tissues around it suppurate, extirpation of the organ becomes an urgent measure. If there is no infection of the wound, the cauterized tissues either will be absorbed or will work their way to the surface, and new connective tissue will spring from the edges of the wound and fill the cavity, and result in a contracted scar. A part of the kidney will be permanently destroyed and there will always remain a fibrous thickening in the region of the wound.

Prognosis.—In considering the prognosis of gunshot-wounds of the kidney a distinction must be made between those received in war and those in time of peace. The former wounds are usually made with larger projectiles having a higher velocity; and, furthermore, wounds received in time of peace are usually more promptly treated by operation. Thus the prognosis in peace is always better than in war.

Treatment.—Gunshot-wounds of the kidney are to be treated in accordance with the principles already given for other renal injuries. If certain symptoms are absent, the surgeon should content himself with cleansing the neighborhood of the wound, and protecting the wound with an aseptic dressing, while keeping his patient absolutely

quiet. Even if there is hæmaturia one can still afford to wait, provided the amount of blood lost is not large. If the hemorrhage is profuse, or if there is evidence of injury of the peritoneum, operation should at once be performed. If the peritoneum is injured, it is better to open the abdomen in order to control the hemorrhage, perhaps from an injured mesenteric vessel, or to suture a possible perforating intestinal wound.

CHAPTER XII.

DISEASES OF THE KIDNEY.

MOVABLE KIDNEY.

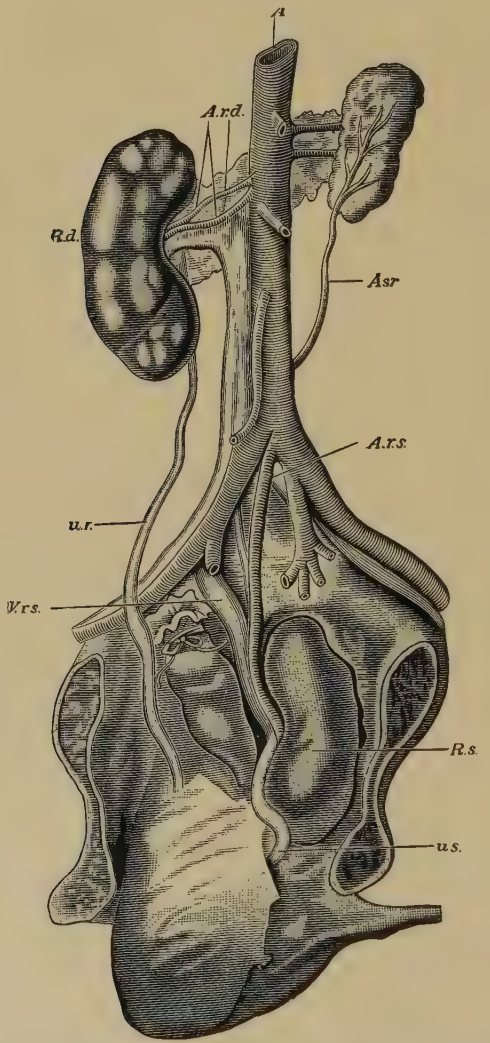
In the chapter on the anatomical relations of the kidney it was pointed out that the fixation of the kidney in its bed is relatively slight. The investigations of Litten, Israel, and others have proved beyond a doubt that the normal kidney has a certain amount of motion with each respiration. Hence its fixation is not absolute. The lower pole of the kidney, especially that of the right kidney, which, on account of the liver, is situated somewhat lower than the left, may be palpable under favorable circumstances, such as a not too great amount of fat, flabby abdominal wall, and a wide space between the crest of the ilium and the margin of the ribs. If a kidney is thus palpable, one can easily observe the motion given to it by respiration. Such a motion of the kidney is to be looked upon as physiological rather than pathological.

Etiology.—The causes which produce an abnormal amount of motion in the kidney, and so give rise to a movable kidney, have been widely discussed. It should be borne in mind that a congenital displacement of the kidney (see page 221) must not be confounded with a movable kidney. Indeed, congenitally misplaced kidneys are usually firmly fixed in their abnormal position.

The fact that 85 per cent. of all cases of movable kidney occur in women, and that such occurrence does not seem to be exclusively the result of childbearing or severe muscular labor, suggests the thought that in the structure of the female body, or in its functions, or in the habits of life of women, there must be some common causes which favor abnormal motion of the kidney. Furthermore, movable kidney of the right side is about fifteen times as common as that of the left, which may be due to the different anatomical structures of the two sides, or to the lower position of the right kidney, or to the stronger development of the arm and the whole right side of most persons. Wolkoff and Delitzin, who have studied these questions very carefully at autopsy, believe that the chief factors which fix the kidneys more or less securely in position are the recesses situated on both sides of the vertebral column. The assistance of such recesses can be demonstrated in a striking manner by plaster-of-Paris casts. If they are well developed, they tend to prevent abnormal motion of the kidney. These recesses present themselves in a well-developed male subject as funnel-shaped spaces, smaller below and equally deep on the right and left side of the vertebral column. In the female subject the

recesses are shallower and cylindrical rather than funnel shaped. In those cases in which the kidneys are movable the recesses are remarkably shallow, and this is especially true of the right side of the body.

Fig. 98.



Left kidney displaced in iliac fossa: *A*, aorta; *A.rd.*, right renal artery; *R.d.*, right kidney; *u.r.*, right ureter; *V.r.s.*, left renal vein; *A.s.r.*, left suprarenal artery; *A.r.s.*, left renal artery; *R.s.*, left kidney; *u.s.*, left ureter. (Bayer.)

These investigators also found that the intra-abdominal pressure of a normal abdomen is of the greatest importance in keeping the kidney in its natural position. If the subject is suspended and the abdominal cavity opened so that air may enter into it, the kidneys at once sink

about 2 cm. (0.8 inch). The same thing happens if the abdominal muscles are removed without opening the peritoneal cavity. As soon, however, as this is opened the lower pole of the kidney sinks still further downward and forward, until it reaches, or passes, the iliac crest. The abdominal wall may be looked upon as a bandage, and the intestines as an elastic cushion, so far as the kidney is concerned. If these facts are borne in mind, the influence upon the kidneys of alterations of intra-abdominal pressure at once becomes clear. Any relaxation of the abdominal wall favors motion in the kidney, while increased tension of the abdominal wall, due to an increase in abdominal contents, will tend to prevent abnormal renal motion.

These conclusions are in accord with those of Becher and Lennhoff, who found that a palpable kidney is so generally associated with a certain type of body that a skilled observer can tell almost at a glance whether a person has or does not have a kidney which can be felt. It is true that a kidney which can be palpated is not necessarily an abnormal kidney, but it is one which is in a condition favorable to abnormal motility. Becher and Lennhoff took as an index of the type of body the relation between the length and circumference of the trunk. This was obtained by dividing the distance from the symphysis pubis to the suprasternal notch, by the smallest circumference of the abdomen, and multiplying the result, to avoid fractions, by 100. The result will be found to vary from 63 to 95, the mean being about 76. It was found to be the rule, with scarcely an exception, that those persons with a high index figure possess a palpable kidney, while those in whom the index figure is low have kidneys which cannot be felt. In other words, palpable kidneys are found almost exclusively in persons with long, slender bodies.

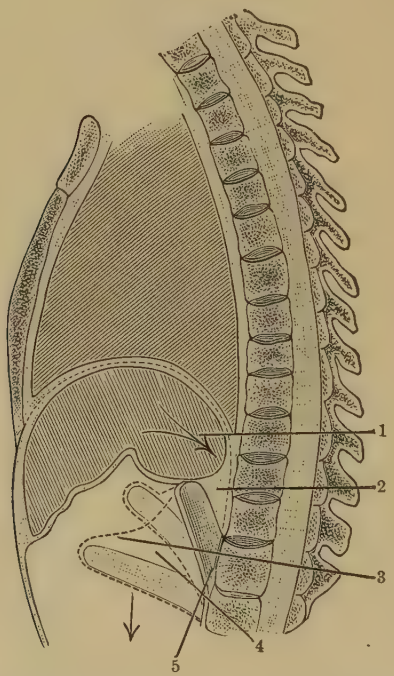
Another cause which is active in women is the transitory hyperæmia of the kidneys during menstruation, which loosens their fascial attachments. Childbearing and possibly severe muscular labor may also have an influence upon the motility of the kidney. Wolkoff and Delitzin lay stress upon tight lacing as a factor in the development of movable kidney. They say that a tight band in the level of the ninth or tenth rib diminishes the depth of the renal recess and thus favors the development of movable kidney. A tight band at the level of the twelfth rib or below may have the opposite effect. Küster believes that tight lacing affects the right kidney more than the left because the former is protected by the liver from moving upward. On the other hand, Becher and Lennhoff do not believe that tight lacing has much effect upon the motility of the kidney, because upon examination of 24 women of Samoa who had never worn corsets or any sort of tight clothing, they found in 6 instances that the kidneys were palpable for about one-third of their length.

Wuhrmann believes that tight lacing is able to displace at least the right kidney by pressing the lower surface of the liver against the upper pole of the kidney. (Fig. 99.)

Movable kidney is sometimes observed in common with a general loosening of the attachments of the abdominal organs to the posterior abdominal wall. Such a condition has received the name of "enteroptosis," or better "splanchnoptosis."

Of more importance etiologically are bodily strains and local traumatisms. Such injuries, as stated in Chapter XI., may cause subcutaneous tears. This is proved especially by those cases in which the violence has ruptured the kidney and has at the same time displaced it from its bed. According to Küster, 92 per cent. of 295 injuries of

FIG. 99.



Illustrating anteversion of the kidney as a step in the development of floating kidney: 1, depression of liver by tight lacing; 2, angle between diaphragm and kidney; 3, peritoneum; 4, rotation and depression of kidney; 5, loosening of kidney. (Wuhrmann).

this character occurred in men. An explanation of this fact is found in the greater protection which is afforded the kidney in women than in men, since the structure of the female body allows freer play to the kidney. It must be further noted that the injuries received by men are apt to be more severe, and the force of muscular strains is likely to be greater in men than in women. This acute displacement of the kidney as the result of muscular effort or accident is coming more and more into notice. Payl has seen it produced by violent lumbar massage.

The position of the kidney is abnormally low in from 20 to 46 per

cent. of all women. Küster says that a movable kidney exists in 94 per cent. of women and in 6 per cent. of men.

Diagnosis.—The existence of a movable kidney can be demonstrated bimanually. (Page 187.) The kidney will be felt beneath the margin of the ribs near the median line, and may be easily pushed back into its normal position. At times it will be so movable that it may be brought down to the crest of the ilium or across the median line. The mass which is felt may be known as the kidney, by its motility, by the possibility of replacing it in the normal recess of the kidney, and by a peculiar pain caused when the organ is pinched between the fingers. This pain is comparable to that caused by compression of the ovary or of the testicle. If the individual examined is very thin, the pulsation of the renal arteries may be felt. The area of dulness due to the kidney is so uncertain that percussion is of no value in differential diagnosis. The diagnosis may be very difficult if on account of adhesions the kidney is fixed in an abnormal situation or cannot be restored to its normal bed. An alteration in the shape of the organ may also puzzle the examiner. The conditions most likely to be confounded with a movable kidney are a constricted lobe of the liver, a cystic tumor of the liver, or a tumor of the gall-bladder, especially if the movable kidney of the right side has caused jaundice. It may further be confounded with a movable spleen or a tumor of the spleen, or with cancer of the stomach or large intestine. If the patient is thoroughly narcotized and a bimanual examination made, combined if necessary with vaginal or rectal examination, a certain diagnosis can usually be made. The symptoms due to movable kidney vary a great deal. Sometimes a kidney which is movable in the highest degree will give no symptoms at all, and this is usually the case if the motility is slight. Thus Brewer examined 11 persons whose kidneys were so movable that the upper pole lay below the costal margin. Yet only 1 of these individuals had symptoms which could be referred to a movable kidney. In other cases there may be a great variety of pains, which can only be explained as due to pressure upon the different abdominal organs, especially the colon and duodenum. There may be dragging and aching pains in the pelvis which extend to the epigastrium, to the sacrum, and to the loins, and assume at times a colicky character. Other symptoms are nausea, vomiting, icterus, obstipation, and palpitation of the heart. Other symptoms which are often seen have to do with the sexual organs, and from this the inference may be drawn that a movable kidney is due to the same causes which produce enteroptosis. At any rate, most who complain of symptoms due to movable kidney are of the nervous type, and describe pains which are partly of a neuralgic and partly of a hysterical character. It is often difficult to say whether the movable kidney is the cause of the suffering or simply happens to be present in some individual and is observed by a person who is in a state of nervous excitability. Be that as it may, the distress may be so marked as to

be unbearable whenever any occupation is undertaken. Such a patient will gladly submit to any operation which promises relief. It has not infrequently happened that these sufferers have been subjected to operation for removal of the ovaries, and the uterus, without the slightest benefit, and have finally been freed from their distress by the fixation of a movable kidney.

Edebohls has called attention to the frequency with which movable kidney is associated with inflammatory condition of the vermiform appendix. He gives the percentage as not less than 60, reckoning all sorts of appendical troubles, from the mildest catarrh to the severest attacks requiring immediate surgical relief. He found, further, that the fixation of the kidney exerted a favorable influence upon the condition of the appendix, so that operation upon the latter organ was avoided in milder cases.

Edebohls explains this association of troubles in the following manner: A movable kidney presses upon the duodenum and pancreas. The superior mesenteric vein which carries the blood from the appendix passes across the transverse portion of the duodenum and behind the upper margin of the pancreas, where it unites with the splenic vein to form the portal. A movable kidney must compress the mesenteric vessels between the head of the pancreas and the vertebral column. This sets up a venous congestion, the effect of which will be seen in inflammation of the appendix. He also speaks of the frequent association of movable kidney and inflammation of the biliary tract—cholecystitis, pericholecystitis, and cholelithiasis.

Persons with movable kidneys are subject to peculiar attacks, or cramps of the kidney, first described by Dittel. Such an attack is marked by a sudden and continued, and often increasing pain of great severity, which may be associated with nausea and vomiting, collapse, and a profuse perspiration and small pulse, or with chills and high fever. The kidney will be found extremely sensitive, so that, except in the case of the best controlled individuals, an examination without an anæsthetic is impossible. There will be found in the situation of the kidney a rounded tumor surpassing the kidney in size to a greater or less extent. Usually the attack passes off in a few hours or days as suddenly as it came on. If the attack is long continued, its termination is followed by the passage of a great quantity of urine.

There is no longer any doubt that such an attack is due to a sudden obstruction to the escape of urine from the renal pelvis. It is therefore acute uronephrosis. Such a condition may be brought about by a change in the ureter, or in its relation to the renal pelvis, while the vessels are unaffected. In the case of a movable kidney, however, the obstruction is due to a kinking or twisting of the whole hilus, including the vessels as well as the ureter; hence the kidney suffers from obstruction to the venous outflow, as well as from obstruction to the flow of urine, and there will be added to the distention of the renal

pelvis the acute swelling of the renal parenchyma and the stretching of the fibrous capsule of the organ. This being the case, it is easy to see why the pains are so great and continue so long, and why they do not disappear spontaneously when the obstruction is relieved. The anatomical relations of a well-developed movable kidney make it plain that such a kinking or twisting of the hilus may easily be brought about if the kidney is not only movable hither and thither behind the peritoneum, but has pushed itself forward into the peritoneal cavity until it has practically a mesonephron. The further this process advances the easier it is for a kink or a twist to occur. Indeed, instances have been observed in which there was a double or a triple twist in the pedicle of the organ.

Treatment.—The object of treatment is to relieve the kink, or twist, which has taken place. An attempt should first be made to replace the kidney in its normal situation. This will relieve any kink which exists, but will not affect the twist. In order to relieve this one ought to be familiar with the mechanism of its occurrence. Wuhrmann, Hertz, and others have stated that the usual twist of a movable kidney is about its transverse axis, the upper pole passing forward and downward, while Albarran, Picquet, and others hold the contrary view. The last-mentioned observers claim that the lower pole of the kidney strikes against the anterior abdominal wall and is prevented from sinking lower, and that the upper pole slips down behind it and becomes the lower one. By this means the hilus is twisted from 90 to 180 degrees, according to the extent that the twist is aided by contraction of the abdominal muscles. Such an accident will produce the severest symptoms, for the pedicle is not a long one. If this theory of the twist is correct, one should press the kidney forward, grasp it with both hands, and attempt to untwist the hilus by pressing the lower pole, which lies uppermost, forward and then downward. This has occasionally been done with success, but there are doubtless instances in which the twist has taken place in the opposite direction. If the kidney cannot be replaced at once, the patient should be kept absolutely quiet on his back, in the confident expectation that the attack will almost certainly pass over in a few hours, or at most in a couple of days. If this hope is not realized, an open operation may be necessary. This should take the form of a nephropexy, which will not only cure the existing attack, but also prevent recurrence. If operation is refused, the renal tumor should be aspirated from behind the peritoneum with a fine needle.

The first efforts of one who is called upon to treat movable kidney should be directed toward prevention of the further motility of the organ. If heavy lifting, jars, or undue motions have caused the trouble, the patient should be cautioned against their repetition. If relaxation of the abdominal walls is present, a well-fitting abdominal bandage should be applied. A combination of a broad elastic abdominal bandage with an exactly fitting corset, as recommended by Philipp,

is often of service. The abdominal bandage is applied first. In the lower margin in front this bandage has two hooks, which catch in the corset and so prevent the bandage from working upward. In this manner one can avoid the use of the unpleasant perineal straps. Other forms of bandage have also been used with good effect. They act by pressing the abdominal organs against the kidney and thus affording it better support. But they fail in the case of thin persons, in whom they exert pressure upon the most prominent bony points, and fail to compress the anterior abdominal wall. Under such circumstances a large pad which covers the greater part of the abdomen and is held in place by a firm bandage will often give relief. Many surgeons, as well as instrument-makers, hold the erroneous idea that it is possible with a pad to press against a movable kidney in such a way as to keep it up in its normal position. A moment's thought will show that this is impossible. It could only be done by making enough pressure upon the abdominal wall to cause it to project inward. This is a practical impossibility, for no patient will be able to stand so great a pressure of a pad. Every time the patient coughs, or sneezes, or makes any muscular exertion which increases the intra-abdominal pressure, the pad will be lifted and the kidney will have an opportunity to slip downward. If it does so, the pressure of the pad against the kidney will then only serve to prevent its return and to press it still further downward. Dorsal decubitus has the same effect as a bandage, hence it is unnecessary to wear a bandage during the night. Moreover, long-continued rest in bed will often greatly improve the condition of the patient, especially if at the same time forced feeding is resorted to. The increased deposition of fat in the abdomen, and especially the better development of the fatty capsule of the kidney, will reduce the tendency of this organ to sink from its normal position. It is beyond question that a movable kidney can be cured by these simple measures, which will, however, fail in severer cases. It gives one an idea of the severity of the suffering which may be caused by a movable kidney to recall that extirpation of the organ was practised by Martin in 1879, and by several others in the succeeding years. Fortunately, better measures have taken the place of this mutilating treatment, which had a mortality in those days of about 25 per cent.

In 1881 Hahn proposed to fix a movable kidney by six or eight catgut stitches passed through the posterior portion of the fatty capsule. This method was very imperfect since no attempt was made to restore the organ to its normal position, but simply to fix it in the lumbar wound, in the hope that, being unable to move about, it would no longer give rise to painful symptoms. A kidney treated in this manner lay mostly below the ribs, and was exposed to all sorts of injuries, which it could not escape by slipping out of the way. Furthermore, it was found that the suture of the fatty capsule alone was not sufficient to hold the kidney in its new position, so that the method was soon improved and variously modified; some operators suturing through the

fibrous capsule, some through the parenchyma, some removing a portion of the fatty capsule, and others of the fibrous capsule, in the hope of obtaining more extensive adhesions between the kidney and the

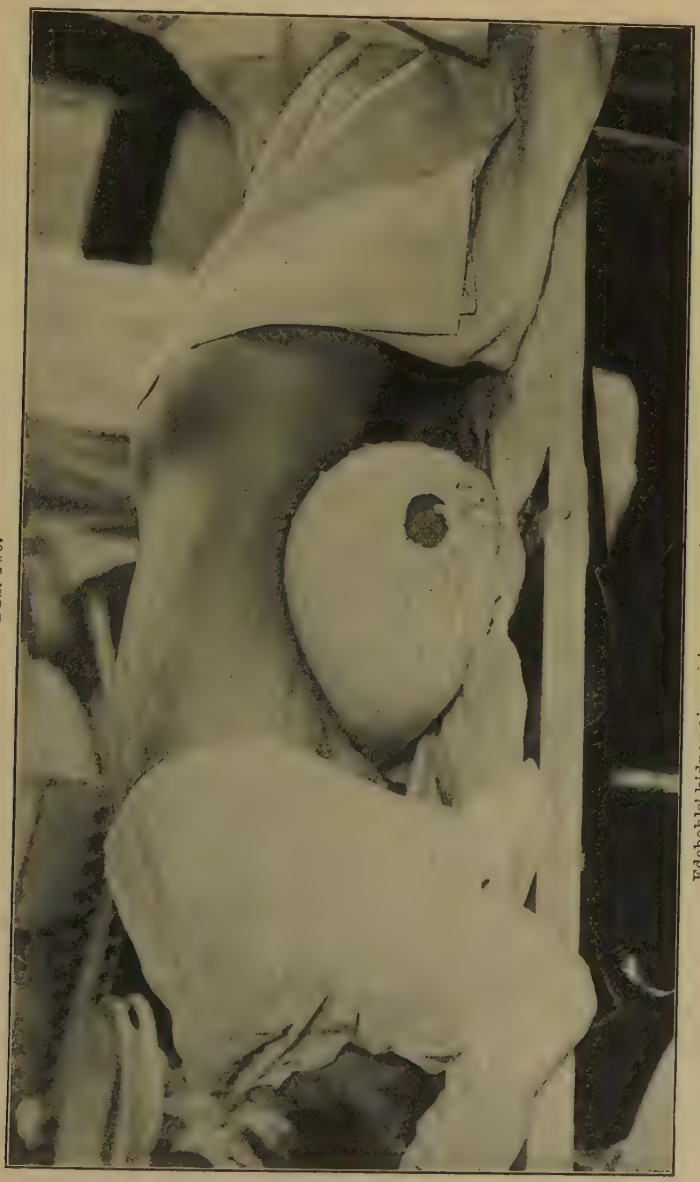
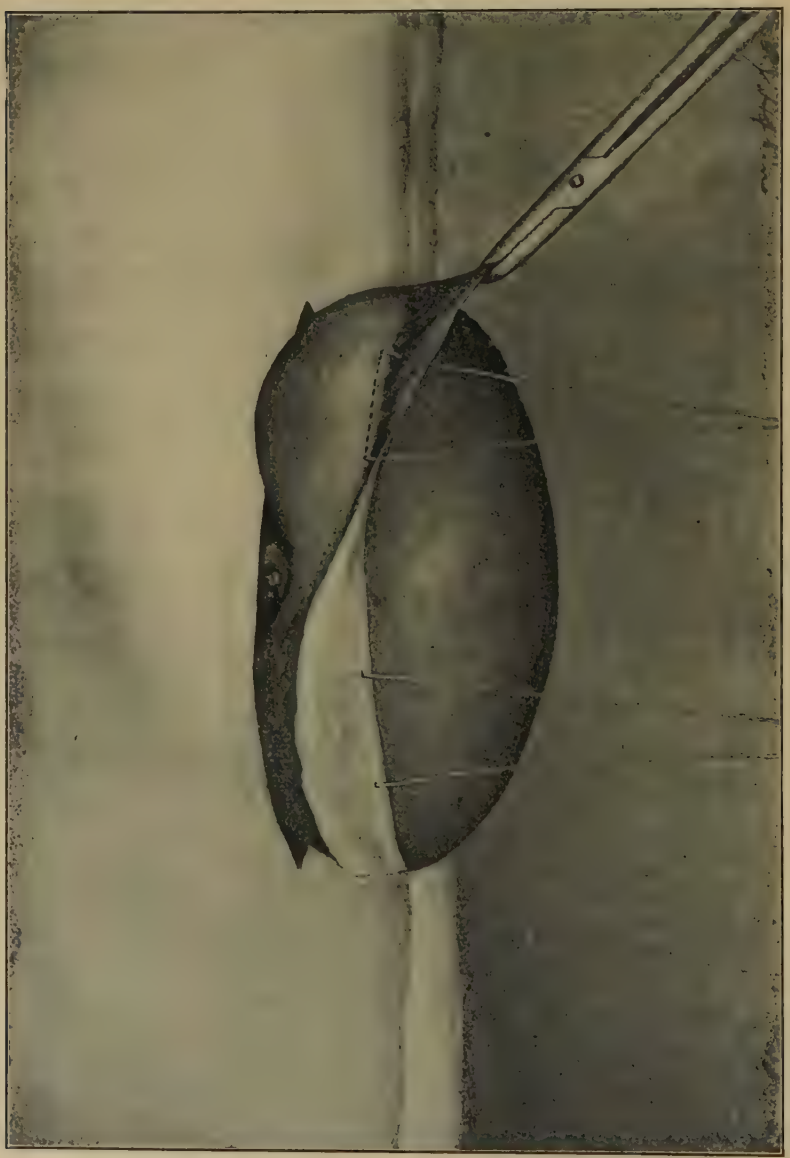


FIG. 100. Edebohls' kidney air-cushion, with patient in position for operation.

surrounding tissue. The method which is now considered the best is that recommended by Lloyd, and consists in a partial decortication and subsequent suture of the kidney.

Attempts have been made to fasten the kidney by a transperitoneal operation ; but as it is only in exceptional cases that the kidney, even a movable one, possesses a meson, it will rarely or never happen that it



Showing two suspension sutures through kidney capsule. (Nephropexy by Edebohls' method.)

Fig. 101.

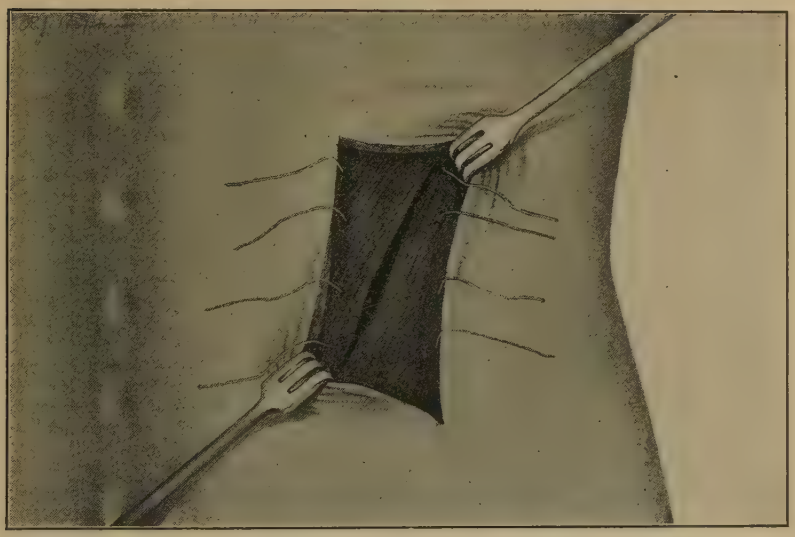
cannot be fixed by the retroperitoneal method. The transperitoneal method is therefore anatomically inferior, while clinically it has a higher mortality. It should therefore be adopted only in exceptional

cases in which there are abdominal adhesions or other complications, or in which the diagnosis is uncertain.

The incision generally used for retroperitoneal nephropexy is the original longitudinal incision of Simon. This incision has been variously employed by different surgeons, but the chief variations introduced by different operators have reference to the preparation of the surface of the kidney and the method of inserting the sutures. A few of the various operations are here briefly described.

Obalinski makes an incision in the fibrous capsule in shape like the capital letter "I." The perpendicular portion of the "I" follows the convex outer margin of the kidney. The two flaps of the capsule which are thus formed are stitched to the inner surface of the lumbar muscles. In this manner the raw surface of the kidney is brought into intimate contact with the tissues of the lumbar region, while the stitches do not pass through the renal parenchyma.

FIG. 102.



Showing sutures in abdominal wall. (Nephropexy by Edebohls' method.)

Edebohls places his patient in ventral decubitus on an 8-inch cylindrical cushion. He makes a long incision, divides and removes the fatty capsule, and incises the fibrous capsule in the same manner as does Obalinski. The flaps are reflected back upon the kidney. The sutures are passed through the parenchyma of the kidney at least 1.5 cm. (0.6 inch) deep, and also through the lumbar muscles. A drainage-tube is inserted, but all the tissue-planes are closed by suture in order to obtain primary union. In his more recent operations Edebohls removes the whole fibrous capsule of the kidney.

Some operators lay especial stress upon the fixation of the kidney

as high up as possible. (De Paoli and Duvet.) Tillmanns for a time resected the twelfth rib in order to fix the kidney still higher. Afterward he found he could suture the kidney into the eleventh intercostal space without resection of the twelfth rib.

Jonnesco stitches the kidney to the periosteum of the eleventh or twelfth rib through a wound along the lower margin of the twelfth rib, or, if this is very short, along the margin of the eleventh rib. He resects the fatty capsule and peels the fibrous capsule from the outer surface of the kidney. The suture passes through all the tissues of the edges of the wound, then through the reflected capsule and the substance of the kidney and the periosteum of the eleventh or twelfth rib. Three sutures are necessary, one in the upper portion of the kidney, one in its middle portion, and one in its lower portion. The end of each suture is fastened by a little roll of gauze. The edges of the wound are closed by separate suture. In his later operations Jonnesco uses silver wire, which he does not pass through the parenchyma of the kidney, but only through its fibrous capsule. The sutures are removed in ten days, but the patient remains in bed for twenty days. His method is said to fix the kidney in an almost normal position.

Riedel makes an incision from the middle of the twelfth rib obliquely to the crest of the ilium. He removes the fatty capsule and also the fibrous capsule from the whole posterior surface of the kidney. He then pushes the kidney upward so that only its lower half appears, and sutures the median portion of the fibrous capsule to the anterior surface of the kidney. The remnant of the fibrous capsule is stitched to the peritoneum and subserous fat. A thick fold of iodoform gauze is passed between the kidney and the diaphragm, and a tampon is placed under the kidney in order to keep it crowded well up. The border of the sacrolumbalis muscle is stitched to the abdominal walls over the tampon. The gauze tampons remain in place four weeks and are then changed for smaller drains. The patient remains in bed from ten to twelve weeks. Riedel's idea is not only to fix the kidney high up, so that it shall be out of the reach of injury, but also to attach it to the diaphragm, as he believes respiration has a bearing upon renal secretion.

Senn avoids the use of sutures by removing the fatty capsule and scarifying the fibrous capsule with a needle. Strips of iodoform gauze are drawn under the lower third of the kidney and the wound is also tamponed. A mass of gauze as large as the fist is bandaged to the abdomen in the further attempt to keep the kidney up in its normal position.

Küster simply fastens the lower pole of the kidney in order to allow it to make the normal amount of rotation on its transverse axis during respiration.

Wagner divides the fibrous capsule along the convex margin, and removes a strip of it 2 cm. (0.8 inch) in width. The rest of the

kidney is scratched and scraped with a knife and the edges of the fibrous capsule are stitched to the muscles. Four silk sutures are introduced as a further support. These are passed according to Rotter's idea, not straight through the kidney, but in a curve, concave upward, so that when they are tied the kidney is lifted upward. In this manner one can cause almost the whole of the kidney to disappear above the costal margin.

Most operators seek to obtain healing of the wound by primary union. Others tampon the wound and allow it to granulate, believing that the scar will help to retain the organ in a correct position. An additional safeguard is the tamponing of the pocket into which the kidney was displaced.

Schede removes part of the fatty capsule, freshens the surface of the kidney by reflecting the fibrous capsule, and passes the stitches through the reflected capsule obliquely upward through the abdominal wall close to the twelfth rib. These sutures are not tied, but are fastened around rolls of gauze. The false bed of the kidney is also tamponed with gauze.

Nephropexy is not a dangerous operation, having a mortality of not more than 1 per cent. This mortality is wholly due to accidents of one sort or another, and ought to be still further reduced since no important organ is injured by the operation itself.

Results of Treatment.—The effects of an operation must be noticed in respect to the position of the kidney and in respect to the disappearance of the symptoms. Formerly an operation often failed to fix the kidney, or did so only temporarily. Such failures were for the most part due to insufficient suture. Under such circumstances a patient may well be advised to undergo another operation by a better method.

It is also true that operations which result successfully so far as fixation is concerned do not always cure the patient of his symptoms. It has already been mentioned that many movable kidneys exist without symptoms, and consequently the symptoms complained of by some patients are probably not dependent upon the movable kidney. If this is so, fixation of the kidney can scarcely be expected to relieve the symptoms. This is, however, a difficult question to decide, and the fact remains that a great number of patients are cured absolutely and primarily by operation, while a great many others are so much improved that they are able to resume their occupations. Complete failures at the present time are not often seen.

Edebohls, McRae, and some other American surgeons remove the appendix through the lumbar wound made to fix a movable kidney. This is not always easily accomplished. In 4 of 56 operations Edebohls found it necessary to make an additional anterior abdominal incision. This surgeon also advocates the examination and possible treatment of coexisting biliary lesions through the lumbar wound.

CHAPTER XIII.

RETENTION-TUMORS OF THE KIDNEY: URONEPHROSIS, PYONEPHROSIS, AND ABSCESS.

Dilatation of the pelvis of the kidney and of the calices follows partial or complete obstruction to the outflow of the urine from the renal pelvis. If such obstruction continues, the increased pressure under which the urine, and possibly some additional pathological fluids, are excreted, will lead to the development of a cystic tumor which may reach a large size. If there is simple retention of aseptic urine, the condition is spoken of as hydronephrosis or uronephrosis. If the urine is mixed with pus, the term pyonephrosis is generally employed. This distinction is simple enough in theory, but practically the two conditions are not so sharply to be differentiated. Secondary inflammation may change a hydronephrosis into a pyonephrosis, while a pyonephrosis arising from a suppurative pyelitis may change in character, by reason of the fatty degeneration of the pus-corpuscles and an alteration in the character of the inflammation, until the sac contains only a cloudy fluid having a certain percentage of mucus and albumin. Therefore some writers have proposed to group all retention-tumors under the name cystonephrosis, and to use an adjective to describe the character of the contents. This plan, however, has little to recommend it, and it has not been adopted by many writers. If another classification is to be adopted, it ought to be one which would indicate rather the origin of the trouble than the character of the contained fluid. It is of far greater importance to know whether the disease is due to a mechanical obstruction or to a primary infection of the kidney. Israel has shown that uronephrosis usually occurs in the first three decades of life, while pyonephrosis belongs to a later period of life.

Guyon and Albarran have suggested three terms—uronephrosis, as indicating a retention-tumor containing aseptic urine; uropyonephrosis, if urine and pus are present; and pyonephrosis, to indicate distention with pus alone. Although this classification has not supplanted the older nomenclature, there is much to recommend it, and it will be used in this section. Before describing in detail the etiology of the different forms of disease and their significance for the organism, and the treatment adapted to them, it will be well to consider the effects upon the kidney of any obstruction to the outflow of the urine, of whatever nature. This will avoid a great deal of repetition, in spite of the fact that there are many variations from the common type.

The obstruction existing may be complete or incomplete, and this

whether the condition is one of uronephrosis, uropyonephrosis, or pyonephrosis. In the case of uronephrosis the backing up of the urine in the kidney and the effect upon the renal function varies according to the length of time that the obstruction lasts, and according to whether the obstruction is complete or incomplete. It is also different if the obstruction is a constant one, and if it is one which came on gradually. If the urinary outflow is suddenly obstructed, the excretion of the urine continues and there is a very great increase of pressure in the renal pelvis and in so much of the ureter as is open. Experiments upon dogs have shown that this pressure may rise to 71 mm. of mercury. The natural effect is a dilatation of the pelvis of the kidney to the fullest extent which its elasticity permits, and a further increase in size due to overstretching of the tissues. This gives rise to intense pain and marked reflex phenomena and renal cramp which have been described in connection with movable kidney. The first effects upon the kidney itself are a marked venous hyperæmia and an œdema of the parenchyma. These changes, combined with the increased pressure within the pelvis of the kidney, lessen from the first hour the urine excreted, and also affect its quality by reducing the amount of urea and salts which it contains in solution; but, even though the condition lasts a long time, the excretion of urine does not cease entirely, and hence a very large uronephrosis may follow an abrupt obstruction to the flow of urine. Such is not always the result, and instances are on record in which the obstruction of one ureter, the kidney being healthy, has given rise to pain and vomiting, which subsided in a few days, no apparent uronephrosis having followed.

A microscopical examination of the renal parenchyma under such conditions shows a dilatation of the tubules in the pyramids and cortex, and a dilatation of the glomeruli, so that the loops of capillaries are widely separated from Bowman's capsule. The epithelium is at first swollen and granular, but it gradually flattens out and ultimately disappears, and its place is taken by proliferating connective tissue. While the parenchyma is thus being destroyed, its sac is extending more and more. On the surface the calices of the kidney bulge outward, and are easily recognized from the outset, while viewed from the inside they form little extensions of the general sac, being separated from one another by thin connective-tissue septa. As the stretching of the sac-wall goes on these septa grow less prominent, and the calices grow shallower, until, in a very old uronephrosis, the cystic cavity has smooth walls with a grayish-white lining, while its form is only faintly suggestive of its previous structure. It takes a long time to reach this stage. For years a thin, shell-like cortex will persist, whose remnants of parenchyma are still able to excrete a small quantity of urine containing only a trace of solids in solution. Even after the lapse of years, if the abnormal pressure is removed by operation, or a spontaneous reopening of the ureter, these remnants of parenchyma are capable of an increased amount of work.

A kidney dilated by complete obstruction of the ureter never attains the size which a kidney does whose urinary outflow is incompletely obstructed. If the obstruction is complete, the continued renal secretion is counterbalanced by resorption through the cystic wall. If the obstruction is removed, a temporary pyuria will follow in a relatively short time (hours or days). This urine is clear, of low specific gravity, and often contains blood. The free excretion of urine which follows an attack of renal cramp, or an intermittent hydronephrosis, consists in part of the retained urine. In about two days the natural flow of urine is resumed.

If the total retention lasts a longer time, and is then relieved, there will be a marked increase in the quantity of urine excreted, so that it may even exceed the quantity excreted from the normal kidney. The excretion of urea is also somewhat increased, but it always remains far below the normal amount. It is seldom more than 1–4 grammes to the litre, whereas the normal is 15–20 grammes. This lack of solid contents is due to alterations in the mucous membrane and in the parenchyma, and to the formation and contraction of the interstitial tissue. This is a permanent condition which is not capable of improvement. Nevertheless, it is important to remember that the urine which is first excreted after the obstruction is relieved is no index of the capacity of the kidney. One must wait several days before forming an opinion of what work the damaged kidney can do. It will then be time enough to answer the question whether the organism can survive the removal of the remnants of the diseased kidney.

The conditions in uropyonephrosis are essentially the same as those in simple uronephrosis. In pure pyonephrosis the kidney excretes practically no urine; perhaps a trace of urea may be detected in the contents of the sac. Still, after the sac is opened, the condition may change to that of uronephrosis.

It is obvious that an incomplete obstruction cannot injure the parenchyma of the kidney to the extent that a complete obstruction does. The degree of injury will in general be measured by the time and degree of the obstruction. Further, in incomplete obstruction the pressure on the renal pelvis is less than that which exists in complete obstruction, and hence the flow of urine will continue in a somewhat diminished quantity. If under such circumstances the obstruction gradually increases, the stretching of the sac will go on until it reaches an enormous size. Instances of uronephrosis in which the sac has extended into the pelvis and pressed aside the uterus are not so very uncommon. Such a cystic tumor may well be mistaken for an ovarian cyst. Even under such conditions, if the pressure is relieved, partial restoration of the renal parenchyma is possible. It is obvious that the quantity of the urine excreted by such a dilated kidney must not be taken as a measure of the work it is capable of doing. To determine this both the quantity of the urine and its solid contents should be considered. These two vary in an extreme degree. The diseased

PLATE VII.

Single Uronephrotic Kidney on the Right Side and Degenerated Cystic Kidney on the Left. Specimen from a Child Aged Six Years. (Wyss.)

kidney will sometimes surpass the healthy one in the quantity of urine excreted, and at other times in the concentration of its urine. In some instances the urine from the diseased kidney is so dilute and in others, although concentrated, it is so scanty, that it counts for little in the general economy. If an incomplete obstruction which has produced uronephrosis or uropyonephrosis gradually becomes complete, the high pressure which is seen after a sudden complete obstruction will be wanting. The pelvis of the kidney has in the meantime become much dilated, and the urinary excretion has markedly diminished; hence the stretching of the sac is gradual, while the excretion of the urine decreases more and more. The patient is therefore saved from the extreme symptoms of acute complete obstruction.

URONEPHROSIS (HYDRONEPHROSIS).

Obstructions to the urinary flow in the case of uronephrosis may be situated in the upper or lower urinary passages. The causes may be either congenital or acquired. Different writers have separated cases of uronephrosis into primary and secondary, according to the existence of one or the other of these conditions; but such a division has no special value. Congenital uronephrosis is due to anomalies of the ureter, which either ends blindly or has a very small opening into the bladder or elsewhere; or the ureter may spring from the pelvis of the kidney too obliquely, or from some portion of the renal pelvis which does not permit of easy outflow of urine. Other congenital causes are the existence of valves in the ureters, or strictures, or twists; or the ureter may be compressed by some abnormally placed artery or vein, or by an accessory ureter (Fig. 103), or by cysts developing in the remains of Müller's duct. The child at birth may have a well-developed uronephrosis and may be incapable of life. Indeed, the tumor due to uronephrosis may be so large as greatly to interfere with the birth of the child. Frequently other anomalies are also present which may have an effect upon the life of the child. On this account these anomalies have been much better studied immediately after birth than at a later period.

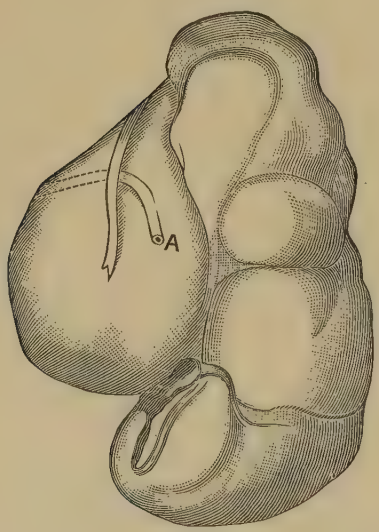
If the congenital obstruction is of a slight character (stricture, compression, kinking), its effects may not be shown until the cause of obstruction has increased. Under such circumstances it may be difficult to say whether the obstruction is of a congenital or acquired nature.

The subject of acquired uronephrosis has been much studied of late and is far better understood than formerly. There are a great number of possible causes. Very serious, long-continued obstruction to the flow of urine leads to dilatation of the urinary passages above, and ultimately to uronephrosis. However, an obstruction situated in the lower passages, such as phimosis, stricture of the urethra, hypertrophy of the prostate, etc., does not play an important part in the causation

of uronephrosis, for the reason that it must act on both kidneys alike. As one can live only a short time with obstruction to the flow of urine from both kidneys, attempts will quickly be made to relieve the obstruction.

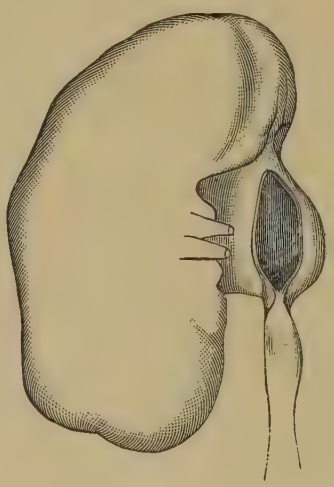
While it is evident that the mouth of the ureter may be narrowed or closed by a scar or a new growth, it is nevertheless true that the chief causes of uronephrosis are to be found in the ureter or in the pelvis of the kidney. Inflammatory processes associated with the female genital organs, such as parametritis, compression by a retroflexed uterus, whether pregnant or not, and compression by tumors, are sufficient causes. Obstruction may be due to urinary calculi; but in a still greater number of cases the occlusion is due to a diseased

Fig. 103.



Intermittent left uronephrosis: *A*, ureter which is adherent to the wall of the renal pelvis and terminates obliquely. (Braun.)

Fig. 104.



Stricture at the beginning of the ureter in the renal pelvis. (Sudeck.)

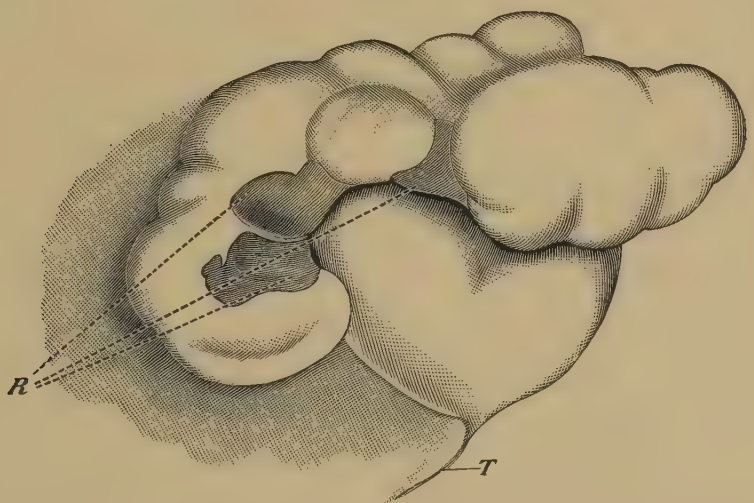
condition in the ureter, such as ureteritis, of a gonorrhœal, tuberculous, or proliferative type; ureteral and periureteral abscess, papilloma of the ureter, etc. A discussion of these various diseases will be found in the section on the ureter. Of these various inflammatory processes, gonorrhœal stricture is most often the cause of obstruction. This is by no means a rare condition. Tuffier found that fistulas persist after nephrotomy in 45 per cent. of the cases. This fact, he says, can only be explained by the frequency of ureteral stricture.

It is often difficult to explain the existence of a stricture. They are sometimes found without evidence in the history of the patient of a previous ureteritis. If the patient is a child, one naturally thinks of a congenital narrowing which may lead to a chronic inflam-

mation, and gradually to the formation of a stricture; but such an explanation will be impossible if the patient has had a healthy childhood and youth, and shows the first signs of stricture in adult life. Sudeck has found under such circumstances an increased number of elastic fibres in the pelvis of the kidney, at the mouth of the ureter, and in the ureter itself. He believes that these can lead to obstruction without an infectious pyelitis. In all cases the epithelium is wanting at the point of stricture. (Fig. 104.)

Another congenital anomaly whose influence may be shown later in life is the twisting of the ureter. An instance of this occurring in Schede's practice is shown in Fig. 105, the patient being a woman

Fig. 105.



Uronephrosis, due to twisting of the ureter at *T*: *R*, *R*, remains of renal parenchyma. (Schede.)

aged forty-nine years. At operation it was found that the ureter close to the kidney was twisted about 360 degrees. In this kidney the normal vessels were wanting; there were some branches to the upper and lower poles. The renal substance was for the most part destroyed. The absence of the normal vessels shows that the trouble was a congenital one. Although by repeated obstructions both the kidney and the upper portion of the ureter had been greatly dilated, the twist was so sharp that at the time of operation the obstruction was complete.

Traumatic Uronephrosis.—Traumatism, and especially severe contusions of the abdomen, may cause stricture of the ureter. This seems evident enough, and yet exact knowledge of the subject is only a few years old. Smith called attention to it in 1871, having seen a patient who was kicked by a horse and suffered for a little while with hæmaturia. Two years later he had a well-marked uronephrosis, from which 9 litres of a reddish fluid containing both white and red blood-

cells were withdrawn. He died a little while after of some other disease, and at autopsy the cause of the typical uronephrosis was found to be impermeable stricture in the upper part of the ureter.

In 1896 Wagner collected 23 cases of uronephrosis, in 10 of which the cause was certainly traumatism, and was probably so in the remainder. Many other cases have since been reported. From these cases it is evident that uronephrosis may follow both slight and severe injuries of the ureter. In one case there was an extensive extravasation of blood around the ureter, which probably gave rise to compression, by the formation of periureteral connective tissue.

In other cases traumatism of the kidney may give rise to uronephrosis. This may be either as a result of blood-clot, or connective tissue following upon it, or it may be due to a kinking in the ureter. Rupture of the kidney may separate the pelvis and a portion of the organ from the rest of it, and so give rise to a sort of uronephrosis within the fibrous or the fatty capsules.

It will thus be seen that traumatism may lead to uronephrosis in a variety of ways. It is not, however, safe to assume that every fluctuating tumor in the lumbar region following traumatism is a uronephrosis. In the chapter on Injuries of the Kidney it was pointed out that blood and urine pouring out from the kidney into the surrounding tissues may cause a fluctuating tumor which may finally be resorbed. Such "pseudo-uronephrosis" has been described by Monad. Israel mentions an unusual cause of uronephrosis—displacement of the kidney occurring as the result of marked lateral curvature. In two patients he found the kidney pushed from its bed and situated in front of the spine. These kidneys were not abnormally movable, but every change in position had sufficed to obstruct the ureters.

Perhaps the most interesting form of uronephrosis is that which develops in a movable kidney. The occurrence of renal cramps in connection with movable kidney has been spoken of on page 250. These attacks are undoubtedly due to retention of urine in the renal pelvis, the result of a sudden kinking of the ureter, associated with a kinking of the large vessels. There follow intense congestion, œdema, and swelling of the renal parenchyma,—conditions which much increase the symptoms present. Movable kidney may cause obstruction simply by sliding downward and thus kinking the ureter at the point where it is held by the posterior peritoneum, or it may twist the ureter by rotation on its transverse axis. The connection between these attacks and the development of uronephrosis is shown not only by clinical and statistical reports, but also by experiment. Terrier and Baudouin were able to establish beyond a doubt the development of uronephrosis from a movable kidney 28 times in 66 cases, while this causal relation was probable in the remaining 34 cases. It is also to be noted that both movable kidneys and uronephrosis occur usually on the right side and in women. Tuffier found that 21 of 25 cases of intermittent uronephrosis occurred in women, while

in 21 of 23 cases the trouble was on the right side. He also experimented upon 9 dogs, making their kidneys movable: 5 of them developed uronephrosis, which was at first intermittent, but later constant. All showed a sharp kinking of the ureter 2–3 cm. (0.8–1.2 inches) below the renal pelvis. Replacement of the kidney invariably removed the kinking and relieved the uronephrosis. Hildebrand and Hayn performed similar experiments upon rabbits, but failed to obtain uronephrosis unless the ureter was fixed by a silk thread.

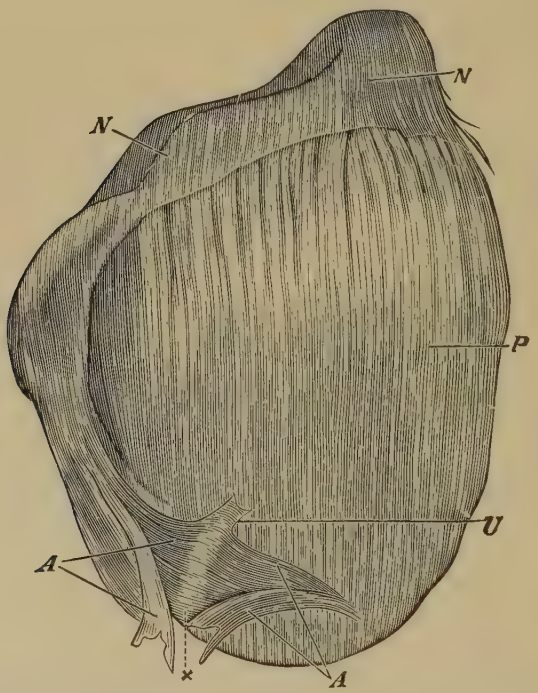
Uronephrosis produced by the causes mentioned is usually not continuous from its beginning. Kinking of the vessels of the hilus and of the ureter due to some sudden strain or fall produces ordinarily only a temporary obstruction to the flow of urine. This kinking may sometimes be overcome by manipulation, as mentioned under Movable Kidney. But in the majority of cases relief occurs spontaneously after some hours or days (up to eight days, at least), although it is not clear how this takes place. It has been suggested that the anterior wall of the renal pelvis is the first to give as distention comes on, and that this, by compression of the ureter, increases the difficulty, and that later, as all portions of the pelvis take part in the distention, the kidney moves upward more into its normal position, and thus the kinking is overcome and the passage is freed for the flow of urine. It must be admitted that it is not clear why the kink does not recur as soon as the kidney is partly emptied.

When once the obstruction is removed, the condition is nearly if not quite the same as before the urinary flow was obstructed. There will be a certain flabbiness of the renal pelvis due to its former distention. Whether the pathological changes are or are not such as to prevent the restoration of the parts will depend upon the frequency of new attacks and the length of time they continue. The renal pelvis is not very elastic, and hence if stretched for some time it remains permanently increased in size. Also, the severe circulatory disturbances which accompany every acute attack of urinary retention lead to strong serous effusion into the tissues, accompanied by the infiltration of white blood-cells, by small hemorrhages, etc. These pathological conditions lead easily to the development of fibrous tissue in the submucous and periureteral spaces and to thickening of the mucous membrane. As a result there is increased resistance to the flow of urine, and possibly formation of a stricture, so that the urine can only escape after the pressure in the renal pelvis is increased. When this has taken place, the intermittent uronephrosis has become a remittent one. That is to say, in the intervals between attacks, although the patient may be free from pain, there persists a moderate dilatation of the renal pelvis and renal calices which becomes more marked with each attack.

As the kidney increases in size and weight it sinks ever deeper, carrying with it the renal end of the ureter. Thus the kinking which occurs is constantly emphasized as the renal pelvis descends forward toward the

median line, and the ureter comes gradually to lie in the posterior wall of the sac. As each attack increases the connective tissue around it, the two portions of the loop which forms the kink will gradually become attached together. One of these is already attached to the posterior abdominal wall, and the other one to the kidney. These pathological changes are shown in the accompanying illustrations. In Fig. 106 the ureter is shown emerging from the posterior wall of the renal pelvis, about 5.5 cm. (2.2 inches) above its lower margin. An earlier

FIG. 106.



Posterior surface of a uronephrotic sac containing 4 litres (quarts): *N*, kidney; *U*, ureter; x, original site of the ureter; *P*, dilated renal pelvis; *A*, *A*, connective tissue. (Israel.)

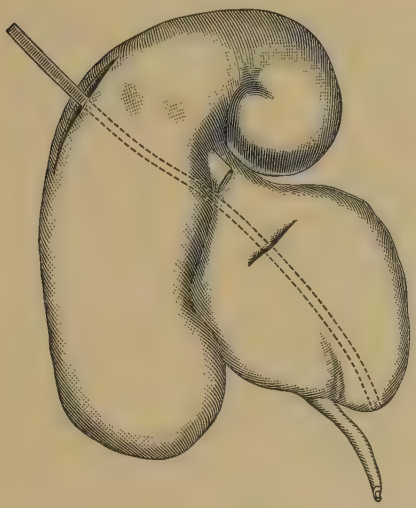
stage of the same condition is shown in Figs. 107 and 108. Israel has several times observed that in kinking of the ureter its first portion extends upward for a distance of 1.5–5.5 cm. (0.6–2.2 inches), then makes a second turn downward to continue its normal curve.

The knowledge of the pathological changes makes it easy to see how an incomplete uronephrosis can gradually become a complete one, since the ascending portion of the ureter can easily be pressed against the posterior wall until it acts as a sort of valve.

If obstruction from any of the causes mentioned occurs in the ureter of a kidney which is in its normal position, the results will be somewhat different. The stretching of the renal pelvis will take place

forward, outward, and downward, as it is limited behind by the posterior abdominal wall and inward by the vertebral column. The parenchyma of the kidney together with the calices will be pressed outward

Fig. 107.

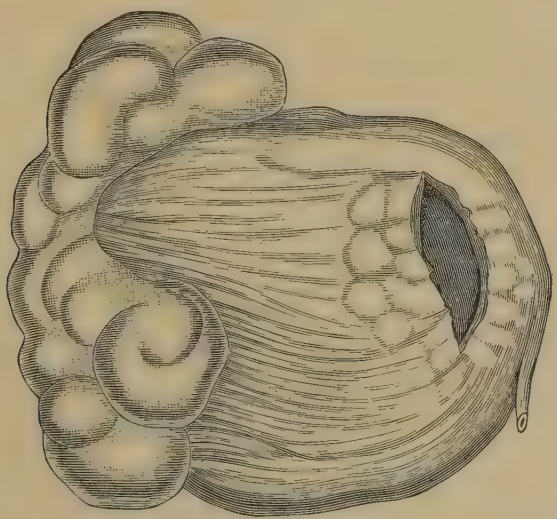


Intermittent uronephrosis. (Morris.)

Fig. 108.

Right uronephrosis, seen from behind. (Morris.)

Fig. 109.

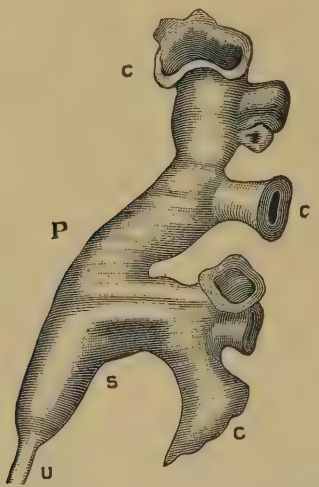


Right pyonephrosis. (Morris.)

and backward, while the opening of the ureter which is situated normally inward will be gradually rotated forward and outward until it comes to lie between the dilated sac of the kidney and the peritoneum

which covers it. That is to say, a uronephrotic kidney turns slightly on its long axis from within forward and outward. As the pelvis distends downward it follows that the opening of the ureter is left behind, and so it may appear to be moved upward, since it enters the kidney somewhat further from the lower pole than is normally the case. This will be better understood by examining Figs. 109 and 110, one of which represents pyonephrosis of marked degree, while the other shows a cast of a normal renal pelvis and calices.

Fig. 110.



Cast of renal calices, pelvis, and ureter: P, pelvis of kidney; C, calices; U, ureter; S, distance of ureter from renal parenchyma. (Henle.)

With a gradual distention of the renal pelvis the ureter is constantly carried further away from the parenchyma, and the distance, which is marked S in Fig. 110, becomes constantly greater. Moreover, the line of the pelvis, which at this point is normally concave, becomes flattened and finally convex, as the pelvis gradually takes on a spherical form, as shown in 109. It has already been stated that it is easier for the pelvis to distend forward and downward than upward and backward, and this explains why the ureter appears to be gradually carried toward the top of the uronephrotic kidney. This takes place just as it would if the pelvis were made of India rubber, and the lower portion of its wall were much thinner than the inner and upper portion. If one blew up such a pelvis, it would distend downward, while the ureter would be relatively displaced upward and inward.

If the sac be examined from within, it will be seen that the ureter penetrates its wall obliquely, so that there is often a valvular obstruction to the outflow of urine. This condition has been mentioned by numerous observers, but no satisfactory reason for it has been given. It was previously supposed that this valvular condition was a congenital one,

but this opinion has been given up, partly because the condition is found in persons who are known to have acquired uronephrosis late in life, and partly because the condition disappears after the sac has been artificially drained. The proper explanation is given by Simon, who says: "Uronephrosis may result from any obstruction in the ureter. If the ureter above the obstruction is not very much dilated, it will be drawn into an oblique relation to the wall of the pelvis. Under such circumstances there will be a valvular obstruction, the lower half of the dilated renal pelvis compressing the upper half of the ureter. The mechanical principle involved is the same as that seen in diverticula of the œsophagus in which the portion of the œsophagus immediately below the opening of the diverticulum kinks and closes like a valve."

Küster has a different explanation, which he gives in every case of uronephrosis whether or not a valvular action is present. He believes that the beginning of the process is a simple catarrh of the renal pelvis. This of necessity implies some swelling of the mucous membrane which narrows the lumen of the ureter. If there is an increased excretion of urine, as may, for example, happen if the patient drinks an unusual amount of fluid, it is easy for the quantity of urine excreted to be too great for the capacity of the ureter, and obstruction of urine follows. As soon as the intrarenal pressure is increased, the swollen mucous membrane, being movable upon its deeper tissues, is displaced in the direction of the flow in a manner similar to the development of strangulated hernia. A fold is thus formed which the urine will have more and more difficulty in passing. Not until the dilatation has reached a certain degree can the altered position of the kidney, which is so emphasized by Simon, produce the obstruction. Indeed, it cannot do this until the tumor is in a position to make direct pressure upon the ureter.

Hansemann affirms that there is a fixed relation between the direction of the free margin of the valve and the direction of the greatest pressure in the renal pelvis. This direction is indicated by the side wall, which is most distended. If the opening of the ureter is fixed, the internal pressure must of necessity change its shape by dragging the lip of the ureteral opening in the direction of the greatest distention. A small portion of the inner surface of the ureter is smoothed out in continuity with the renal pelvis. The lip which lies opposite to this forms a sharp angle, or a valve, which invariably points toward the direction of the greatest pressure. Figs. 111 and 112 show these relations in diagram. Fig. 111 shows the normal relations, and Fig. 112 shows the condition brought about by a pull downward. The portion of the wall at *a* is continuous with the renal pelvis, while *k* forms a sharp angle or valve which points in the direction of the greatest tension.

This explanation of Küster may not be the correct one in every case of uronephrosis with open ureter and no dislocation of the kidney, but it sounds reasonable and gives one a clear understanding

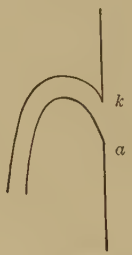
of the condition which exists. It should be remembered, however, that the motility of the mucous membrane may also take part in the formation of the valve, a fact which is recognized by Küster himself.

The four causes of uronephrosis are these: compression of the ureter, narrowing of its lumen, obstruction of its lumen, and changes in the position of the kidney which are capable of producing kinking of the ureter. In addition there are certain cases in which the cause is not clear unless it be the valvular formation mentioned by Küster; or unless simple swelling of the mucous membrane of the renal pelvis, combined with a congenital narrowing of the mouth of the ureter, can produce so serious a disorder.

Fig. 111.

Normal relation of ureter to renal pelvis.

Fig. 112.



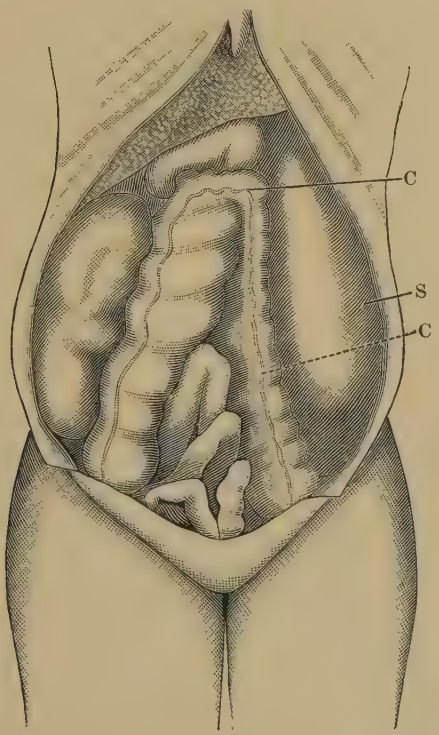
Relations of ureter and distended renal pelvis.

In respect to intermittent uronephrosis, it should be emphasized that this condition is not confined to movable kidney, but can occur in kidneys which have no more than the normal amount of motion. If the flow of urine from such a kidney is constantly interfered with by some chronic condition, a relatively trivial cause, such as the drinking of a great quantity of beer or the swelling of the mucous membrane from exposure to cold, may suffice to bring on an attack of uronephrosis. Uronephrosis may perhaps also be caused by simple inflammatory swelling of the mucous membrane without previous partial obstruction. Finally, attacks of distention and pain may be brought on in case of chronic incomplete uronephrosis whenever the rapidity of the urinary secretion exceeds the possibility of its discharge; or whenever a temporary obstruction is added to a chronic one. Whether such an acute attack is accompanied with great pain or not will depend on the degree of tension which is necessary to overcome the obstruction to the urinary flow. Pain is due to the stretching of the renal pelvis or renal capsule. As simple retention of urine can only affect the renal pelvis, while retention of urine combined with kinking of the vessels of the hilus can produce also an acute congestion and an acute œdema of the kidney with an enormous tension of the fibrous capsule, it is self-evident that the latter condition is likely to be much more painful, and to be accompanied by symptoms of collapse, which may be wanting in a simple urinary retention. Hence, it is desirable to

make a distinction between cases of so-called renal cramp or strangulation and those of intermittent uronephrosis, reserving the term "strangulated kidney" for those cases in which a movable kidney has kinked the ureter and vessels of the hilus, and the organ has therefore suffered from intense congestion in addition to urinary retention.

Symptoms.—The symptoms noticed in the beginning of uronephrosis vary a great deal according to the different causes. Violent attacks, which may be brought on in the course of intermittent uronephrosis by kinking or twisting of the hilus, are in sharp contrast to the symptoms which in other cases are produced by gradually increasing compres-

Fig. 113.



Right uronephrosis. The stomach (S) and colon (C, C) are displaced to the left.

sion or gradually narrowing stricture. Under such circumstances the development may be so easy that the patient notices nothing until the cystic tumor has reached a considerable size and is discovered either on account of its size, or on account of the sudden feeling of pressure and tension, or on account of its influence upon other organs, such as the colon or stomach. The symptoms referable to the stomach and intestines are loss of appetite, nausea, raising of gas or fluids, thirst, and constipation. In the tumor itself there is a constant feeling of

fulness and discomfort, which is occasionally increased to actual pain whenever the sac becomes overdistended. Such pains may shoot into the genitals or into the back.

A glance at Fig. 113 will show the influence of uronephrosis upon the position of the neighboring organs, and explains how easily disturbances in their function may follow. The transverse colon is obliquely placed, and the stomach is nearly vertical and much distended.

If the kidney is not previously dislocated, it will occupy, as it grows, the space between the lumbar region and the outer portion of the anterior abdominal wall. It will be plainly felt below the ribs, and, if it is not too large, it will show all the signs which are given by other enlargements and tumors of the kidney, including ballottement—that is, the direct transference of the pressure of a light blow from one side of the tumor to the other. It will also exhibit the characteristic relations of the kidney to the ascending or descending colon, which will cross over the tumor obliquely or vertically. If this distention of the kidney increase still further, the resulting tumor will press the diaphragm upward and the ribs outward, and occupy more and more of that side of the abdomen, possibly extending into the pelvis ; and, even crossing the vertebral column.

The consistence of the tumor also varies. A long-standing and large uronephrosis almost always gives a typical fluctuation-wave and has a smooth and even surface. A small uronephrosis of short duration may have such a high tension that it feels as hard as a solid tumor. The intense pain which it causes ought to prevent one from making this error in diagnosis. In other cases the surface is irregular, corresponding to the dilated urinary calices. Sometimes, if the abdominal wall is thin, one can recognize that the wall of the cyst is thinner in parts corresponding to the calices.

The effects of a long-continued obstruction to the urinary flow have already been mentioned. If the condition exists on both sides, it cannot develop to a high degree, but will cause death by uræmia in a comparatively short time.

If the uronephrosis is unilateral and complete, the urinary excretion from the affected kidney will cease entirely. If the obstruction is an incomplete one, the excretion will be more or less diminished according to the increase in pressure, and the urine will contain a small percentage of solid matter. If the other kidney is sound, it will take up the function of the diseased one through increase and dilatation of the excretory elements of its parenchyma. This compensation may be so complete that the total amount of urine excreted equals the normal amount, and the contained urea and other salts may even be present in normal quantity. If double uronephrosis is present to a limited degree, symptoms of chronic interstitial nephritis may develop. There may be an excretion of a large amount of urine of low specific gravity, containing only a small percentage of solid contents.

The older a uronephrosis is, the less will the fluid contained in it present the characteristics of urine. When the last vestige of renal parenchyma has been destroyed, a process which often takes years for its accomplishment, the last trace of urea and uric acid will disappear from the contained fluid. The fluid will then be simply the secretion of the cyst-wall, and may be clear or cloudy, of watery character, containing a little mucin and albumin; or, it may have a more colloid character, or contain flakes of cholesterin, etc. A uronephrosis may disappear of itself, but this result can only follow the disappearance of its cause, such as removal of the compressing tumor, passage of the obstructing renal calculus into the bladder, or freeing of the kink caused by a movable kidney. A complete uronephrosis may in the lapse of years lose all of its contents and shrivel up.

One of the risks in connection with uronephrosis is the rupture of the sac as the result of traumatism. This may lead to serious or even fatal hemorrhage, or to discharge of the contents of the sac into the peritoneal cavity. If the sac ruptures behind the peritoneum, it is theoretically possible that the discharged fluid be resorbed and the condition become as before the accident. Infection may occur in a uronephrosis and change the condition to one of uropyonephrosis or pyonephrosis.

Diagnosis.—The facts already stated are usually sufficient to establish the diagnosis of uronephrosis or of some cystic tumor of the kidney. Occasionally the differential diagnosis between cystic tumors, or between a cystic and a solid tumor of the kidney, is a difficult one, and instances will not be wanting in which it is difficult to determine whether a cystic tumor is or is not connected with the kidney. Cystic tumors, not connected with the kidney, which may lead to error in diagnosis, are echinococcus of the liver, cystic dilatation of the gall-bladder, and tumors of the ovary. It is better to postpone the differential diagnosis of the various cystic tumors of the kidney until they have all been considered separately.

The situation of an echinococcus cyst of the liver may be such as almost exactly to simulate that of a cystic tumor of the kidney. Its immobility and the impossibility of separating it from the liver are signs which will often serve to mark it out. It is difficult to understand *a priori* why a dilated gall-bladder should be mistaken for a cyst of the kidney, and yet many surgeons have made this mistake. The two organs may be intimately associated, so close, indeed, that a fluctuation wave may be felt in the loin when the gall-bladder is struck, or in the reverse direction. If one can demonstrate the attachment of a cystic tumor to the liver, it is clear that the swelling is of the gall-bladder.

Another common error which even celebrated surgeons have made is the mistaking of an ovarian tumor for a cystic kidney. The development of modern methods of pelvic examination is of great service in this differential diagnosis; but, in spite of this, there are cases in which a mistake may easily be made.

It is thus evident that the largest tumors may be the ones which are the most misleading. If a tumor reaches from the vaginal vault to the diaphragm, and the history of the patient does not show in what situation it began to develop, it is plain that the diagnosis may be difficult. In such a case the fact that the tumor is wholly on one side of the abdomen will speak in favor of the kidney, since even a very much dilated kidney rarely passes the median line, while very large ovarian cysts occupy a position almost in the centre of the abdomen, irrespective of their point of origin, unless earlier adhesions prevent their natural development. If the cervix uteri is seized with forceps and drawn strongly downward, while the surgeon examines the patient with his finger in the rectum, he can usually determine whether or not the tumor is connected with the uterus or its appendages. The relation of the tumor to the large intestine is also a valuable sign. This can be made out by passing a soft rubber rectal tube and blowing up the colon with air from a bulb syringe. This method of examination may fail, since a congenitally misplaced kidney, or a movable kidney, may not have the usual relation to the colon.

It was formerly the custom to settle these difficult diagnoses by puncturing the cyst and aspirating some of its fluid. This method of examination is not wholly without risk, and is somewhat unreliable. In an old uronephrosis the urea is reduced to the minimum and a small quantity of urea may be found in the contents of an ovarian cyst. The contents of such a cyst may be thin and watery, while a uronephrosis may contain a colloid or mucoid fluid. In general, it may be said that the result of an examination of the fluid is significant only if it reveals the presence of echinococci, bile, or a considerable quantity of urea.

On these accounts, and because of the slight risk of an exploratory laparotomy, aspiration of the cyst contents as a means of diagnosis has been generally given up. It should only be undertaken under circumstances in which it can be immediately followed by operation. If the tumor appears to be ovarian, the incision should be made anteriorly. If it appears to be a uronephrosis or other retroperitoneal tumor, a lumbar incision is preferable. If the anterior incision shows that the tumor lies retroperitoneally, the wound should at once be closed and a lumbar incision made.

Treatment.—During the last thirty years the ideas of surgeons with reference to uronephrosis have undergone many changes. The ancient methods of treatment were very unsuccessful. Puncture was the usual treatment, the needle being inserted ordinarily from in front. The results were most unsatisfactory, especially since it was impossible to determine beforehand in what cases one might expect benefit from this method. The tumor was incised from in front after the anterior and posterior layers of peritoneum had been made to adhere by numerous punctures or cauterizations with paste. Even though the peritoneal cavity was thus protected, the opening of the sac of the kidney was

followed by suppuration, from which the patient ultimately died. Simon attempted to remove the whole organ in a number of patients, but found it too difficult; or the patient did not survive the operation. With the introduction of antiseptic surgery it was found possible to remove the diseased organ without invariably taking the life of the patient, and for some years this was the only treatment thought of. A little later, more conservative methods were again practised, and Billroth, Landau, and Pawlik succeeded in catheterizing the uronephrotic sac from the female bladder.

In 1892 Fenger treated uronephrosis with success by overcoming the valvular condition at the mouth of the ureter by means of a longitudinal incision sutured transversely. He applied the same principle to stricture of the ureter with success, while Küster excised the contracted portion of the ureter and implanted its free end in the uronephrotic sac. Since that time the whole subject of conservative treatment in this class of cases has been thoroughly studied, and there are to-day a number of excellent methods which are well worth a brief description.

1. Albarran has shown that it is possible to catheterize the pelvis of the kidney, both in men and women, from the bladder, and to follow such catheterization with irrigations of nitrate of silver. This method of treatment may effect a cure of uronephrosis in a limited number of cases.

2. Puncture of the sac is still of therapeutic value under circumstances in which it is necessary to obtain temporary relief from dangerous symptoms; for example, if it is necessary to obtain additional space in the abdominal cavity on account of a pregnant uterus, or some other abdominal tumor. In case of anuria as the result of uronephrosis, if the condition of the patient does not permit more complete operation, puncture is employed. Puncture will often relieve a patient from the terrible symptoms of renal strangulation, and it may be that after the size of the kidney has been reduced it will be possible to replace the organ and to keep it in position with a suitable bandage. Puncture is also of service as a single or repeated measure in obstruction due to temporary displacement of the urinary passages, or when caused by calculi or blood-clots, as well as in true traumatic uronephrosis (periureteral extravasation of blood) or in false uronephrotic extravasation. In old, completely closed sacs, after the destruction of all the parenchyma, puncture may have a curative as well as a palliative effect. One can never count on more than a temporary effect of puncture in any of these cases, and this method of treatment should not be employed except when there is a clear indication for it, as in the instances cited above.

An aseptic puncture is in itself a harmless method of treatment, but this condition is often out of the reach of a surgeon to secure, since it depends not only upon his preparation, but also upon the character of the uronephrotic contents. If the sac contains infectious

material, a perinephritic suppuration may follow a puncture. If the operation itself is not performed aseptically, suppuration may be brought about within the sac. Puncture should, of course, be made extraperitoneally; hence it is well to distend the colon with air in order to show the relations before thrusting in the needle. The posterior margin of the tympanitic percussion-note will indicate the point of reflection of the peritoneum. If the needle is inserted a little way back of this, the peritoneum will not be wounded. Israel recommends that the needle should be inserted in a line drawn from the point of the twelfth rib to a point on the crest of the ilium 6 cm. (2.4 inches) behind the anterior superior spine.

3. If a uronephrosis is intermittent and a kidney is abnormally movable, its fixation may prevent obstruction due to kinking of the ureter and of the vessels of the hilus. Guion first operated in this manner, and since then the operation has frequently been performed with success. While some of the results which have been attributed to the operation might possibly have occurred without operation, there is no reasonable doubt that under conditions fixation of the kidney will prevent recurrence of uronephrosis. It is essential that the obstruction be due to a kinking of the ureter, and that this kinking be not firmly fixed, and that it disappear when the kidney is brought into the position into which it is to be sutured. Under such circumstances the operation is indicated even though one cannot give an absolute promise of success.

4. The sac may be incised extraperitoneally (lumbar nephrotomy). When this method of treatment was previously employed, its sole object was to provide a way of escape for the urine by establishing a fistula in the pelvis of the kidney. There are numerous cases, however (Wagner says about one-third), in which after simple incision of the sac the flow of urine through the ureter is gradually resumed, and the fistula into the kidney, being no longer needed, closes of itself. Sometimes the unfavorable valvular action of the mouth of the ureter improves so much after the uronephrotic sac is opened that the conclusion is inevitable that the valvular action is the result of the uronephrosis, and that the uronephrosis was due to some cause not apparent at the time the nephrotomy was performed. This point, however, needs further investigation. In some instances the position of the sac while in the cutaneous wound, or the partial removal of the sac in order to reduce its volume, has stretched the mouth of the ureter and has thus done away with the valves. Under such circumstances nephrotomy has cured an intermittent uronephrosis.

If the nephrotomy does not lead to a cure a renal fistula will persist, which will discharge a variable quantity of urine. It is evident that if the urinary obstruction is complete, the whole discharge of the sac-wall and of the remnants of renal parenchyma must escape through the renal fistula. The quantity of fluid thus discharged may exceed one litre per day. It is easy to imagine how

troublesome such a condition must be to a patient. If the obstruction is only partial, the quantity of urine discharged from the fistula will vary greatly. If the wall of the sac swells and interferes with the escape of the urine through the ureter, the discharge from the fistula will be greatly increased, and *vice versâ*.

But the patient has other troubles besides those which are due to a urinary fistula. Infection of the valves of the kidney through the rubber tube which is used to carry off the urine is likely to take place sooner or later. There will result a suppurative pyelitis with new abscesses in the renal tissue, chills and fever, fissure, and an infective condition which may cost the life of the patient. This suppurative condition frequently makes it necessary to extirpate the kidney.

Since a renal fistula is therefore both unpleasant and possibly dangerous, measures should be promptly undertaken to make it unnecessary. There are several ways in which one may seek to remove the cause of obstruction by operating through the uronephrotic sac. It is often difficult enough to find the cause of obstruction. The little slit-like opening by which the sac communicates with the ureter may not be found until after a search of an hour or more. The incision in the sac ought to be made long, so as to facilitate inspection of its inner wall. If the mouth of the ureter cannot be found, one may stitch the walls of the sac into the wound of the skin and wait for a few weeks to see whether spontaneous cure will follow. Another method is the prolonged incision downward in order to expose the ureter retroperitoneally, and to make a longitudinal incision into it through which a probe may be passed into the renal pelvis. This method will surely reveal the presence of strictures, kinks, etc., which may be overcome at the same operation. This method is to be recommended as one which can be quickly carried out, and will with certainty accomplish the end desired.

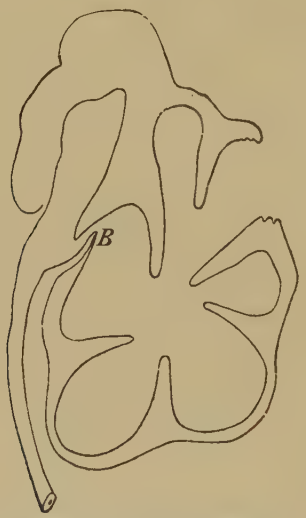
There is a third method recommended by Fenger, in which the sac is widely opened so that the greater portion of it may be removed. Its edges are next stitched in the cutaneous wound. Tampons are kept in it for three or four weeks, during which time it will shrink greatly. Another attempt should be made to find the ureter from the sac, and if this fails the ureter should be sought retroperitoneally.

The commonest forms of obstruction, leaving out of consideration peripheral causes, are valvular action of the ureteral mouth and stricture of the ureter. The diagnosis is usually easy and experience has shown that it is possible to overcome these changes.

5. In 1892 Fenger succeeded in overcoming the valvular action of the ureteral mouth by means of a plastic operation. His patient was a woman aged twenty-eight, with intermittent uronephrosis. The ureter opened in the posterior portion of the sac. The anterior lip of this opening formed a valve which pressed against the posterior lip and closed the opening. This valve was split in the long axis of the ureter and sutured in the opposite direction according

to the well-known principle of Heineke-Mikulicz pyloroplasty. A No. 11 F. bougie was left for two days in the ureter and the renal pelvis was drained. The patient entirely recovered and the external wound closed spontaneously. This operation has been repeated many times in essentially the same form by other operators. Three years later Fenger had occasion to operate upon a student twenty-two years old, who suffered from uronephrosis due to gonorrhœal stricture of the ureter. He performed the operation described above, but still the urine would not flow into the bladder. A more thorough examination showed the condition to be that pictured in Fig. 114. The anterior lip of the ureteral mouth was pressed against the wall which separated

Fig. 114.



Uronephrosis in which obstruction to the flow of urine was kept up by the thin pelvic wall *B*. (Fenger.)

two calices. The longitudinal division and transverse suture of both valves and mucous membrane cured the patient. A similar condition existed in a kidney obtained at autopsy by Fenger many years previously, the inciting cause for the obstruction being in this case compression of the ureter by a perityphlitic abscess. (Fig. 115.)

In 1892 Fenger applied the same principle of operation in the case of a stricture of the ureter near its commencement in the renal pelvis. The outcome of this condition and the operation is shown in Figs. 116 and 117, while a similar operation as carried out by Morris is shown in Fig. 118.

6. Israel sought to overcome the kinking of the ureter and the valvular condition of its mouth by stitching folds in the wall of the sac. In this manner he was able to give the ureter a more direct exit.

7. Resection of a portion of the sac is sometimes of advantage.

Hochenegg, Socin, and Küster have operated successfully in this manner, the latter being able to remove the uronephrotic portion of a horseshoe kidney.

Fig. 115.

Right uronephrosis with valve—vertical section: 1, sac; 2, dilated calices; 3, lining of pelvis; 4, valve formed by 3, and which divides the upper two-thirds of the pelvis from the lower one-third, except at the narrow passage 5; 6, perityphlitic abscess obstructing the ureter.

Fig. 116.

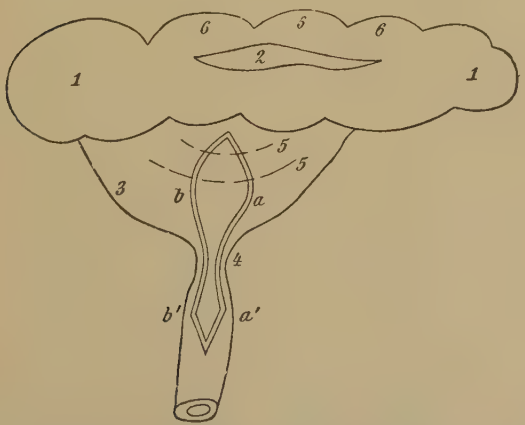


Fig. 117.

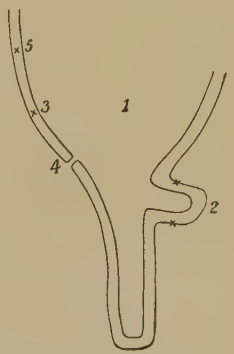
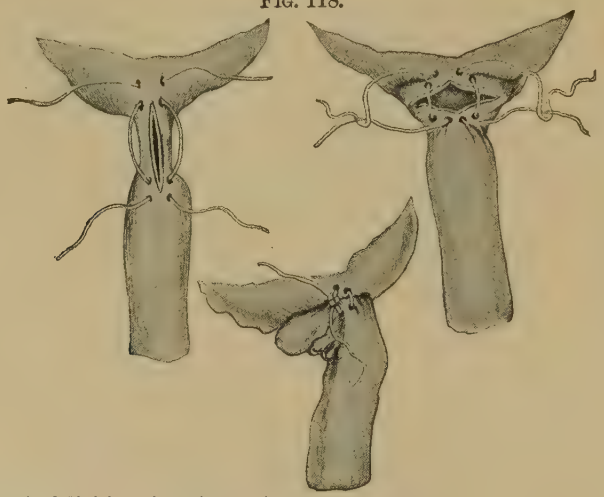


Fig. 116.—Stricture of ureter with commencing uronephrosis, diagram of Fenger's operation: 1, kidney; 2, incision for nephrotomy; 3, dilated pelvis; 4, divided stricture of ureter; 5, sutures to close wound in pelvis. *a*, *a′*, *b*, *b′*, points for transverse suture of ureter.

Fig. 117.—1, pelvis of kidney; 2, fold in ureter at site of stricture; 3, sutures marked 5, 5 in Fig. 116; 4, suture-line due to sutures *a*, *a′*, *b*, *b′* in Fig. 116.

8. Dilatation of ureteral strictures by bougies passed from the renal pelvis is a method of treatment which has not been generally followed. If the stricture lies close to the kidney, a quicker and better result can doubtless be obtained by Fenger's operation, or by cutting off the ureter and reimplanting it in the kidney, as has been done by Küster. If the stricture is further away from the sac, its dilatation is so difficult and trying that it is generally better done after extirpation of the kidney. Schede and Alsberg have reported successful treatment of traumatic strictures by this method. Schede also reports the cure of a patient by this means in which a renal fistula existed for eight years.

FIG. 118.



Longitudinal division of urethral stricture and transverse suture. (Henry Morris.)

9. Jaboulay makes a long incision in the lumbar region, splits the sac, turns it inside out like a glove, and leaves it in the wound. The lining of the sac becomes covered with granulations, and gradually shrinks until only a small fistula remains. It is difficult to see how this method can result in a cure.

10. If probing the ureter or the bladder proves that the obstruction to the flow of urine lies in the peripheral portion of the ureter, it is unnecessary to expose or incise the uronephrotic sac. It is better to attack the ureter retroperitoneally and to overcome the obstruction by resection of the stricture, or division longitudinally and suture transversely. An obstructing calculus in the ureter may be removed in this manner.

11. Witzel has proposed a method of treatment which may be adapted to some conditions, but which has not yet been tried. His plan is to make an incision such as is used for ligation of the common iliac artery, and to expose the uronephrotic sac and the fully distended bladder extraperitoneally. The bladder is next stitched in the

iliac fossa and then emptied. The uronephrotic sac is fixed with sutures which do not puncture the thickness of its wall, and its contents evacuated by puncture. An anastomosis is then made between the bladder and the lowest portion of the sac. The suture of mucous membrane should be an exact one. A rubber catheter is passed into the bladder and through the communication into the hydronephrotic sac, where it is fixed with a catgut suture. This outer end is to be connected with a tube which discharges below the surface of sterile water contained in a vessel. In this manner the sac will be kept always empty, and will quickly shrink.

The surgeon must select from the conservative methods enumerated above the one which is best suited to the case in hand. There will also be cases which cannot be cured by any of the procedures mentioned, and which are best treated by secondary or primary extirpation of the uronephrotic sac. Most surgeons agree that extirpation is the proper treatment for very large, old nephroses. In such a condition it is most probable that the renal parenchyma is entirely destroyed, or that so little of it remains that its function can be disregarded. This fact can be established by a chemical examination of the fluid obtained by aspiration. If this fluid contains only a trace of urea, it shows that the body has been able to get on without the help of the diseased kidney. In doubtful cases the phloridzin method will definitely determine the functional activity of the organ.

A second indication for extirpation is the persistence of a urinary fistula in spite of nephrotomy, and in spite of all attempts to make the urine flow through the natural channels. Failure in this direction may be due to the fact that the obstruction cannot be found, or that when found it cannot be overcome. It seems a mistake to compel a patient to go through life with a renal fistula simply because removal of one kidney may affect the other injuriously or may render it more susceptible to disease. It has been so many times proved that even a well kidney can be suddenly removed without any injurious consequence that one ought not to hesitate to remove a kidney which is not only diseased, but whose functional activity has also been greatly lessened. Furthermore, the technic of operation has been so perfected that the extirpation of the uronephrotic sac by an experienced surgeon is an operation involving slight risk, while a urinary fistula leading into such a sac is, aside from its great annoyance to the patient, a source of danger, since it may lead to infection of the sac, suppuration, and perinephritic abscess.

A third and more pressing indication for extirpation of the sac is the presence within it of suppuration with its accompanying symptoms of pain, fever, emaciation, etc.

In all cases in which the surgeon has the intention to extirpate the kidney, he ought first to determine the functional activity of the other organ. In the case of uronephrosis this is very easily accomplished. In accordance with modern ideas it is the duty of the surgeon to seek

for the obstruction in order to remove it in favorable cases. Therefore the ureter must either be probed through the sac or exposed immediately below the sac. This gives the surgeon the opportunity to obtain the separated urine from the two kidneys for chemical examination.

The lumbar incision is best adapted to all cases of uronephrosis excepting those which occur in a displaced kidney. With care and patience the operation is usually not difficult. As soon as the sac is exposed and the line of the reflection of the peritoneum determined, this membrane is pushed aside with the colon, restraining bands being cut through to make this step possible. If the sac has not been opened, the dissection is carried as far as may be without opening it. Then a trocar is inserted and the contents evacuated, and the wound made by the puncture neatly sutured. The sac being reduced in size will no longer interfere with the continuation of the dissection until the hilus is reached. The vessels are ligated and divided in the usual manner.

If the sac has been opened before the operation for its removal, the wound is first enlarged and the mouth of the sac is dissected free from the abdominal wall. The subsequent steps in the operation are as above described.

The risk of removal of a uronephrotic kidney is slight if the operation is performed under favorable conditions. The records of 124 cases collected by Schmieden from the literature of the last thirty years show a mortality of 18.5 per cent. The figures for lumbar extirpation are much better than those for transperitoneal extirpation; the percentage of mortality for the former being 10.8, and for the latter 27.1. Naturally the results in recent years are far better than those obtained formerly. The mortality from 1870 to 1880 was 44.4 per cent.; that from 1880 to 1890 33.3 per cent., while that from 1890 to 1900 was only 5.7 per cent. Individual operators have had even fewer deaths than this lowest figure indicates. Thus, Küster reports 6 lumbar extirpations, Tuffier 5, Morris 7, and Schede 12, without a single death.

The transperitoneal method of extirpation was formerly much employed in cysts of the kidney, partly because these were so often mistaken for ovarian tumors. But even when the diagnosis was correct, many surgeons held that a large renal cyst could not be satisfactorily handled through a lumbar incision. Experience has shown this view to be erroneous. Even the largest sacs may be extirpated extraperitoneally without difficulty, and while an approach from in front permits the surgeon to obtain a better view of the other abdominal organs, it carries with it a risk of infection from the contents of the sac which more than counterbalances such slight advantage. The single condition which makes the transperitoneal method preferable is a displacement of the organ, either congenital or acquired.

When the tumor has been removed transperitoneally, a large cavity remains behind the posterior layer of peritoneum, and it is sometimes difficult to treat. Schede succeeded in such a case by suturing the

anterior and posterior layers of peritoneum together all the way around the edges of the wound, thus closing the peritoneal cavity and leaving the depths of the wound accessible for gauze packing. Other operators have recognized the value of this procedure and have adopted it in some cases. Heidenhain subsequently opened the abdomen, separated the anterior and posterior abdominal walls, and sutured the peritoneum in its proper relations because he feared that the scar-tissue extending from back to front of the abdomen might produce intestinal obstruction.

SUPPURATIVE INFLAMMATIONS, AND SUPPURATIVE DILATATIONS OF THE KIDNEYS—SUPPURATIVE NEPHRITIS, PYELITIS, AND PYONEPHROSIS.

Suppurative processes in the kidney may develop in various ways. There may be a simple suppurative catarrh of the pelvis (pyelitis), or one or many abscesses of the renal parenchyma (suppurative nephritis, or surgical kidney), or the suppurative process may be associated with retention of urine and pus in the pelvis of the kidney, which becomes thereby distended (pyonephrosis). As the result of pressure and secondary suppuration the renal parenchyma may be destroyed. Sometimes a simple uronephrosis is changed by infection to a pyonephrosis. Sometimes calculi form either in the kidney or its pelvis, to which suppuration is afterward added, and sometimes the formation of calculi is secondary to the suppuration, being a result of the alkaline fermentation. The suppuration may or may not be of a tuberculous character. Sometimes it is associated with paranephritis, sometimes the kidney alone is involved. The different processes mentioned may be variously combined, or one may follow another, or pass into another. Thus it will be seen that the conditions under which suppuration occurs and the symptoms to which it gives rise are very various.

Infection may enter the kidney directly from the bloodvessels, or by extending up the ureter from the bladder. Direct infection from the blood was formerly supposed to be extremely rare, but more recent experience proves it to be quite common. This is not to be wondered at, since the kidney is one of the chief means of exit for pathogenic bacteria which have found their way into the circulation. The germs of measles, scarlet fever, smallpox, typhoid fever, and tuberculosis, and also bacterium coli, staphylococci, and streptococci, all pass through the kidney. It is therefore no wonder that they occasionally remain in the organ and set up suppurative processes. When pyæmia was a common result from a wound, suppurative embolism and infarction of the kidney were of daily occurrence. It was usually followed so quickly by death that renal abscess did not have time to form. The infections which one sees to-day are of a less severe type, and therefore the changes in the kidney may be observed in a later period of development.

The second method by which the kidney may become infected is by extension upward from the bladder through the ureter. The first result of such extension will be a suppurative pyelitis. Under unfavorable circumstances the suppuration may spread into the parenchyma of the kidney. Gonococcus is perhaps the most frequent cause of suppuration occurring in this manner. Other bacteria which have been found are bacterium coli, proteus vulgaris, pyocyaneus, pyogenes ureæ, staphylococcus and streptococcus, and, more rarely, the diplococcus of Fränkel or that of Friedländer. Many of these bacteria are incapable of doing much damage until they are favored by obstruction of the ureter.

It is not yet determined which method of infection is the more important. Bazy, for example, believes that almost all infection in the kidney comes from the blood, while Küster holds the opposite view. Further investigations are necessary to decide between two such widely different opinions.

Suppuration due to tuberculosis and that due to calculi will be considered in connection with those subjects. In this place will be grouped all other forms of suppurative nephritis and pyelitis.

Symptoms.—As suppuration manifests itself in the kidney in such a variety of ways the symptoms which it causes are frequently varied. Perhaps the disease of the kidney may follow an acute infectious fever, such as typhoid fever or scarlet fever, or some local suppuration, such as furunculosis or osteomyelitis. If this is the case, it may begin with chills, with attacks of colic, with gradually increasing swelling and great tenderness and pain on manipulation. The infection may also follow a subcutaneous injury of the kidney. On the other hand, the patient may suffer from cystitis due to gonorrhœa. This may perhaps exist for years before it gives rise to pyelitis and pyelonephritis. If the infection begins as a bacterial embolism in the renal parenchyma, single or multiple abscesses will form and break into the renal pelvis, producing pyelitis; while if the infection comes from cystitis the order of inflammation will be ureteritis, pyelitis, and then infection of the renal parenchyma through the tubules. Such an ascending infection will be accompanied by chills, fever, etc., but these symptoms will not usually develop so acutely as they do when the infection comes from the blood.

Every form of retention of urine predisposes to catarrh and suppuration of the urinary passages. This fact is so well known that it will suffice to give a single illustration, namely, the effect of residual urine in the bladder due to prostatic enlargement. So, in the kidney, bacterial infection is much more serious when it occurs in the presence of a certain amount of urinary obstruction. Thus, a kink in the ureter, a beginning uronephrosis, or even a stricture of the urethra, or a prostatic hypertrophy, or a compression of the ureter during pregnancy, or a narrowing of its lumen due to ureteritis, will favor the development of pyonephrosis. The stagnant infected urine undergoes degeneration and irritates the mucous membrane to the point of suppura-

tion, while the mucous membrane by its swelling further increases the obstruction to the outflow of urine. Ulcers may thus be formed, at first superficial, and then deep. The urine becomes more and more foul, and abnormal pressure injures the inflamed renal pelvis; the parenchyma becomes diseased and bacteria of different sorts find a ready soil for their multiplication. But the obstruction proceeds still further. The retention of urine and pus in the pelvis of the kidney constantly increases, and the fluid collects under great pressure, while as a result of this pressure and the suppuration, the parenchyma of the kidney is destroyed with a rapidity which is unknown in simple uronephrosis.

If infection takes place in a previously formed uronephrosis, the condition rapidly changes into that of a pyonephrosis.

Lennander has recently shown that nephritis developing in cases of cystitis due to prostatic hypertrophy, urethral stricture, etc., is not necessarily urinogenous. It may be due to bacteria which enter the blood from the diseased bladder.

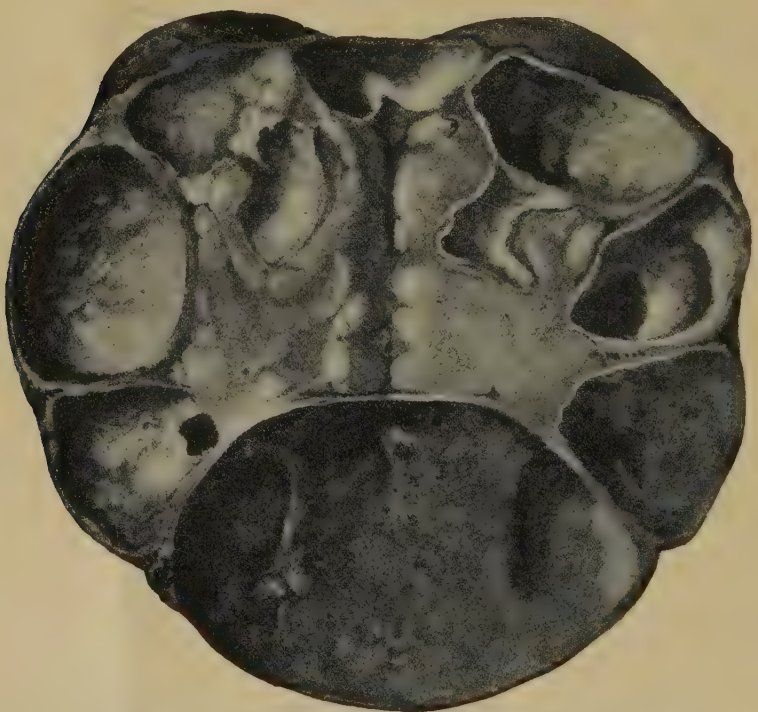
Reblaub, in order to show the effect of bacteria circulating in the blood when there is obstruction of urine, ligated one ureter of several rabbits and injected a culture of staphylococci into the vein of the ear. These animals developed pyonephrosis in four or five days.

The course of infection arising from the blood, or extending upward from the bladder and leading ultimately to pyonephrosis, has been described. Either one of these processes may stop at any point in its progress and recovery may follow. Thus, a gonorrhœal infection may not persist beyond the urethra. Cystitis may not be followed by ureteritis or pyelitis; or a pyelitis may be recovered from before the renal parenchyma has suffered material injury. So with infection coming from the blood. A renal abscess may open into the pelvis of the kidney, or may burst into the perinephritic tissue. If pus is discharged through the natural passages, or evacuated through an incision, the patient may recover. In spite of such fortunate terminations the relation between suppurative nephritis and pyelitis and pyonephrosis is a close one, and, especially if there is obstruction of the urine, the process is likely to extend until the kidney is changed into a sac of pus.

Pathological Anatomy.—The entrance of inflammatory bacteria into the kidney from the blood is marked by little foci in the cortex, in which the bloodvessels may be seen to be filled with micro-organisms. With the naked eye one can often see rows or strings of very fine yellowish dots which are minute abscesses. Sometimes these are arranged in the shape of a wedge with the base toward the fibrous capsule, which may be slightly elevated thereby. In the affected area blood passes into the interstitial tissue, so that the general appearance is that of an embolic infarct due to a plugging of the small vessel with an infectious embolus. A hyperæmic and hemorrhagic margin separates the affected area from the sound tissue. The tissue in the affected area usually breaks down and a small abscess is formed. Sometimes

a great many of these abscesses will be found throughout the kidney, the larger ones formed by the fusion of two or three smaller ones. If the process is extensive, the kidney will be increased in size and covered with slight elevations which correspond to individual abscesses. The kidney may remain in essentially this condition for a considerable length of time, though growing gradually larger. The parenchyma between the suppurating foci is much altered. The epithelial cells become clouded, swollen, or undergo fatty degeneration. The tubules are full of casts and the interstitial tissue is infiltrated with small round cells and filled with growing, new connective tissue. If the

FIG. 119.



Pyonephrosis, showing cysts filled with a white flocculent fluid. No evidences of normal kidney tissue remain. (Wyss.)

destruction of the kidney continues, the organ is changed into a network of more or less degenerated parenchyma which only partly separates the large abscess cavities which have been formed by the fusion of the smaller ones. (Fig. 119.) Meantime the fatty capsule has shrunken and has become firmly fixed to the surface of the kidney by the growing connective tissue. Possibly an abscess has broken through into the fatty capsule by which it is walled about, or the pus may have penetrated the fatty capsule and spread in the retroperitoneal tissue, giving rise to a paranephritic abscess which will be described later.

Whenever the abscess breaks through into the pelvis of the kidney, there develops a condition which is known as pyuria. The mucous membrane of the renal pelvis and of the ureter shows the effect of infection by swelling, possibly to a point of obstructing the urinary flow. An abscess may also obstruct the flow of urine before it breaks into the renal pelvis, by pressing upon or obstructing the ureter. Obstruction may also be due to one of the septa existing between two abscesses. This may flow over the mouth of the ureter and completely obstruct it. The scanty urine from the portions of the kidney which are still capable of excretion mixes with the greater quantity of pus and urine already present in the renal pelvis, and by increasing the pressure already existing it helps to destroy the remnants of renal tissue and flatten out the septa between the different abscess cavities. In this way the multiform cavity will be changed to a single smooth-walled cavity, whose inner surface will, however, suggest its development out of numerous separate cavities.

In other cases the bacteria do not lodge in the bloodvessels of the cortex, but pass through the glomeruli and enter the urinary stream. They are carried into the tubules, where they may lodge and undergo further development. Infection will then appear as fine grayish or yellowish stripes among the straight tubules, which may be so close together in the papillæ as to give a diffuse yellowish or brownish color. The microscopical examination will show that the tubules are distended with microbes and with necrotic or fatty degenerated epithelial cells, but with comparatively few pus-corpuscles. The area affected is surrounded by a zone of fatty degeneration outside of which there is suppuration.

In other cases suppurative nephritis is subsequent to suppurative pyelitis, which, in its turn, is secondary to bacterial inflammation of the bladder. This upward movement of the bacteria is favored by stagnant urine. The alterations in the ureteral mucous membrane are usually less marked than those in the pelvis of the kidney. Changes in the kidney itself first appear in the papillæ; later these changes may extend to the pyramids, and still later to the cortex. If the inflammation is intense, the whole kidney is swollen, hyperæmic, enlarged, and marked by numerous minute hemorrhages. The line between the pyramids and the cortex is indistinct. Suppuration usually manifests itself first in the pyramids, where small abscesses are formed, which, together with the necrosis which goes on around them, may destroy larger or smaller portions of the papillæ. These necrotic fragments may slough off and mix with the urine. Numerous small abscesses may also occur early in the cortex. Micro-organisms are found in the tubules and in the vessels of the cortex, having entered the arteries of the pyramids, according to Orth. The further progress of the disease is similar to that of a suppuration derived from the bloodvessels.

Symptoms.—Suppurative nephritis, if of embolic origin, is accompanied by sharp attacks of colic, due probably to hyperæmia and œdema

of the kidney which stretch the capsule, and produce intense pain. At any rate, such painful attacks are often followed by the appearance in the urine of great quantities of bacteria. In some cases there is no reason to suppose from the symptoms or from the conditions found at operation that these attacks could be due to retention of urine. In other cases painful attacks do not occur, but in their stead there are a dull ache and feeling of pressure. In still other cases there are no symptoms referable to the kidney, so that sometimes a pyuria of an intermittent type may last for years without any pain whatever. Usually there are fever and the disturbances of the general health which one would expect to find. Sometimes the fever is very high and accompanied with chills. Sometimes there is hectic fever with profuse perspiration and rapid loss of strength, while in other cases the temperature is only slightly elevated.

An attack of colic and a sudden rise in temperature may be due to a sudden complete retention of urine. If pyuria has been present for some time, and during a period of pain and fever the urine suddenly becomes clear and quite normal, it is safe to infer that the second kidney is healthy, and that the flow of urine from the diseased one has been suddenly obstructed. If a double pyonephrosis exists, there may be retention simultaneously on both sides, so that total anuria results.

Palpation will usually show enlargement of the kidney and its increased tenderness. Sometimes these clinical signs are wanting. Schede cites a case of long-continued pyuria developing in a boy after typhoid fever, in which for a long time neither kidney was painful nor tender on palpation. Finally there was pain in the left kidney, and the surgeon was able to feel its slightly enlarged outline. At operation it was found to be a mere sac of pus, the parenchyma being fully destroyed, but the urine after operation still contained a little pus, and although the child improved in health for a time, the previous history was repeated, and he finally died after having suffered almost no pain. There was found well-developed pyonephrosis of the right kidney, most of its parenchyma being destroyed.

Diagnosis.—The case which has been cited shows that the diagnosis of suppurative inflammation of the kidney, and even that of pyonephrosis, is in the early stages not easy. If one of the acute exanthemata or a local septic process is followed by attacks of renal colic, with high fever, chills, etc., one ought to think of an acute embolic or metastatic suppuration of the kidney. If a suppurative cystitis, especially one complicated with retention of urine in the bladder (prostatic hypertrophy, stricture of the urethra, or urinary obstruction), pregnancy, etc., is followed by pain and tenderness in the lumbar region, the suspicion is strong that the infection is involving the kidney. If the urine drawn aseptically contains bacteria in a patient who does not suffer from cystitis, the kidney is shown to be infected. If the urine constantly contains pus, and an enlargement of the kidney can be shown, the diagnosis of a suppurative process is certain even

though it is not possible to say whether the suppuration exists in the kidney itself or whether there is a pyonephrosis. A classical group of symptoms which indicates a pyonephrosis is sudden temporary obstruction to the urine, with rapid formation of a very painful tumor, and a clearing up of the urine which previously contained pus, the patient meanwhile growing worse. The diagnosis is also clear if a traumatism precedes such a typical set of symptoms, or if a renal abscess breaks outward (perinephritis) or into the pelvis of the kidney. In the latter case there will be the sudden addition of a great quantity of pus to a previously clear urine. Before the renal abscess breaks into the pelvis one may suspect a hæmatogenous nephritis, but may not be sure of it. The same is true of a urinogenous suppurative nephritis before enlargement of the kidney can be made out, and before necrotic portions of the kidney can be found in the urine.

Cystoscopic examination will often establish a diagnosis in these early cases. Pressure on the affected kidney may increase the flow of pus from the corresponding ureter. If the separate urine can be obtained from the ureters for examination, so much the better.

If for any reason cystoscopy is impossible, the diagnosis of renal pyuria may be strengthened by irrigation of the bladder. When once the water returns clear, it will not become cloudy for some little time if the pus is due to cystitis; whereas if the pus comes from the kidney, it will again become cloudy in a short time. When the urine contains pus, it is sometimes difficult to determine whether a true albuminuria exists or whether the albumin present is due to the pus-corpuscles. If the urine is of alkaline reaction, albuminous products will be caused by the disintegration of the pus-corpuscles as well as by the action of bacteria upon the peptones; hence the usual tests for albumin are deceptive unless controlled by the leukocyte count. If the leukocyte count of the urine shows from 50,000 to 70,000, this is equivalent to 1 part per 1000 of albumin, according to Esbach's test. Pus-corpuscles will practically never give more albumin than this; and if even this quantity of albumin is found with a limited number of pus-corpuscles, it may safely be considered a true albuminuria.

The cystoscope has proved of the greatest help in the diagnosis of pyonephrosis. Furthermore, the separated urine in women may be collected by Rose's instrument, and in women or men by Harris's instrument. These instruments are of great value as supplementing ureteral catheterization through the cystoscope. They are capable of being used by those who are not specialists, and with them separated urine may be obtained under circumstances in which catheterization of the ureters is difficult or impossible. Furthermore, the results of ureteral catheterization are not invariable, and they may well be confirmed by the use of the instrument mentioned. Repeated examinations of the separated urine will determine with great certainty whether it is safe to remove a diseased kidney. To the usual chemical and microscopical examination should, however, be added

the determination of the freezing-point of the urine and the phloridzin test.

Treatment.—The condition of the kidney determines its treatment. If there is an ascending suppurative infection of the renal pelvis, local irrigation through a ureteral catheter combined with irrigation of the bladder should be employed. Internal medication will also help to relieve the condition. This treatment was first carried out by Bozeman. He insisted that obstinate cystitis in women should be treated by functional rest. This he secured by making a large fistula between the bladder and the vagina, which he closed after the patient had recovered. If the renal pelvis was also infected, the fistula in the vagina was so placed as to expose the mouth of the ureter of the affected side. Thus he passed a ureteral catheter for irrigation. Albarran by means of the cystoscope carries out this treatment both in men and women, using for irrigation of the renal pelvis a warm solution of boric acid until the fluid returns clear, and following this with a solution of silver nitrate from 1 to 3 parts to the 1000. Other surgeons object to this method of treatment on the ground that it may produce injury to the patient, as shown by chills, etc., and on the further ground that it may delay operation beyond the time most favorable to it. One objection to this method of treatment is its technical difficulty. Under certain conditions it is almost impossible to catheterize the ureter. Another objection to irrigation of the renal pelvis is the possibility that the catheter may introduce into the pelvis of the kidney germs not already there present, for example, tubercle bacilli. Simple pyelitis will ordinarily yield to internal medication.

If a diagnosis is made of pyonephrosis or suppurative nephritis, the surgeon should freely expose the kidney so as to determine its exact condition. The fatty capsule generally shows such pathological changes as œdema and plastic exudation, especially if a renal abscess is about to rupture externally. After the fatty capsule has been shelled from the kidney the latter will be found congested and swollen, or these changes may be confined to a part of the organ. Sometimes yellow miliary abscesses are seen surrounded by hemorrhagic zones, and here and there forming larger abscesses by their fusion. Sometimes the pus is deep in the kidney and its surface shows only congestion and swelling.

Further treatment depends upon the conditions which are present. Resection and incision and drainage are to be considered.

Partial Nephrectomy.—In a few cases the infection will be so clearly limited to a part of the kidney that a partial resection is indicated. Such an operation has twice been performed by the author, and the primary union which followed justified the treatment. Hemorrhage was controlled in one case by suture, and in the other by tamponade. In each case the lower pole of the kidney was involved.

Nephrotomy.—The general practice is, however, to split the kidney after the vessels of the hilus have been temporarily clamped or

ligated. The tension of the capsule is at once manifest. The parenchyma puffs through the incision in the capsule, and the capsule is easily peeled from the parenchyma on account of the bloody serous fluid lying beneath it. The incision of the parenchyma should be large enough to give a good view of the diseased parts. All abscesses should be freely incised. It often happens that the surface shows only miliary abscesses, but that these fuse together toward the pyramids into cone-shaped necrotic masses.

Further treatment depends upon the exposed condition of the kidney operated on, and upon what is known of the condition of the other kidney.

If the diseased kidney is full of abscesses and so destroyed that it is of little or no value as an excretory organ, one is justified in removing it at once even without a thorough examination of the separated urine, provided that the previous examination of the total urine excreted was satisfactory, and the freezing-point of blood and urine showed that excretion was normal. If the ureter is obstructed, one is not justified in trying to save a small remnant of parenchyma. Nephrectomy gives a speedier recovery and better prognosis. If it is known that the other kidney is also seriously diseased, one must naturally content himself with a nephrotomy. Instances are not wanting in which a cure has resulted in cases which seemed hopeless. Gerster and Lilienthal have saved patients suffering from double surgical kidney, by double nephrotomy, although this is by no means common.

In many cases the conditions will be so much improved by a nephrotomy that the kidney will be able fully to resume its functions. The work of the kidney may be followed by means of cystoscopic examinations, and by collecting the urines separately by Pinner's method, which is easily done after nephrotomy. In this manner it will soon become evident whether a secondary nephrectomy is advisable.

In the treatment of pyonephrosis the cause of the obstruction should if possible be determined by inspection and the passage of sounds; and if the kidney is to be preserved, attempts should be made to overcome the obstruction. In these cases the obstruction is often a calculus which has become wedged in the ureter. Whether the patient will be more benefited by nephrotomy or nephrectomy, must be decided in the same manner as this question is decided in cases of suppurative nephritis.

Nephrotomy to be of the most use must afford free drainage, and to accomplish this Guyon and Albarran have stitched the halves of the split kidney to either side of the incision in the soft parts.

If the ureter is pervious and the other conditions are favorable, the wound in the kidney may granulate to a sinus and finally close altogether. If the ureter is obstructed, the sinus can only close when the obstruction is removed or the renal parenchyma is destroyed or removed.

Even those surgeons who advocate transperitoneal nephrectomy are willing to admit that a suppurating kidney had best be removed through the loin. The risk of a rupture into the peritoneal cavity during operation of a highly infectious renal abscess is too great to be lightly set aside.

Whenever primary or secondary nephrectomy is carried out, it is well not to bury the ligated ureter, but to suture it into the wound. One will thus avoid the unpleasant formation of a "ureteral empyema." This action is especially necessary when there is obstruction between the kidney and bladder. Still, suture of the ureter in the wound does not always prevent the retention of pus, which sometimes will require total extirpation of the ureter. The daily discharge of a few drops of the purulent secretion from such a ureter will give the patient little trouble.

CHAPTER XIV.

CALCULUS OF THE KIDNEY: NEPHROLITHIASIS.

If a foreign body finds its way into any portion of the urinary passages, urinary sediment will quickly form about it, enclosing it. As layer after layer of urinary salts is thus deposited, the foreign body becomes the nucleus of a calculus. This is true of bullets, pieces of catheter, splinters of bone, needles, and of numerous other objects which have been found in the centre of calculi. Although calculi formed in this manner are common enough, they constitute a small minority of all the calculi which exist. Still, they have served an important purpose, and that is, to direct the attention of surgeons and pathologists to a correct explanation of the formation of a calculus. The nucleus may be extremely small. It may be only a little clot of blood, or a bit of necrotic tissue, or a mycelium, or a thread of leptothrix. Calculous disease is very common in Egypt, and a frequent nucleus of a calculus found there is distoma hæmatobium, a parasite which lives in the trunk of the portal vein, or in the veins of the spleen, mesentery, etc., and whose eggs or embryo may pass into the vessels of the urinary tract, and so enter the urinary passages and give rise to calculi. This discovery was made by Bilharz. Wucherer found that filaria sanguinis plays a similar part in Bahia. However, in the vast majority of calculi the world over it is impossible to find any nucleus.

Ebstein, after much labor, was able to demonstrate that every calculus has an organic framework composed of an albuminoid substance which is disposed in concentric layers like an onion, and which is filled with whatever crystals or earths make up the calculus. He believes that the first step in the development of a calculus is the formation of this organic framework. He speaks, therefore, of a calculous catarrh, meaning, for example, that an excess of uric acid injures the epithelium of the urinary passages, causing their destruction, and that the destroyed cells make the skeleton for the uric acid calculus.

Moritz limited very much the force of this theory by showing that there is an albuminoid (colloid) organic skeleton to every crystal of urinary sediment, and, indeed, to every particle of amorphous sediment. By slowly dissolving a crystal under the microscope one can see remaining a delicate albuminoid body which has the same shape as the crystal, and which is capable of being stained with methyl-blue.

It is therefore true that the necessary albuminoid substance for the formation of a calculus exists in every urine. The question

remains unanswered whether some particular increase of this substance favors the development of crystals. Until this question is settled, one cannot speak positively of the method of their formation. It would appear, however, that all that is necessary for the development of a calculus is that a single crystal should be formed in some place where it has the opportunity to lie quiet and to increase in size. Mendelsohn believes that the urine excreted at different hours of the day has a very different composition, and that some of it is so concentrated that its salts are precipitated before it leaves the kidney. Under ordinary circumstances the more dilute urine which follows dissolves this sediment or washes it away. If this action fails, additional salts will be deposited around those previously precipitated, and a calculus will result.

It must not be inferred from what has been said that the composition of the urine is of no importance in the development of a calculus. Thus, the urine of a gouty person is constantly overladen with uric acid; and such a person will be much more likely to develop a calculus than another in whose kidney some urinary sediment is for a single time precipitated. The same is true of the formation of stones made up of oxalates or cystin in persons whose urine favors such sediment. And an alkaline urine predisposes to the formation of phosphatic calculi. However, a continuous abnormal composition of urine is not in itself a sufficient cause for the formation of calculi even though one must admit that certain calculi form only in constantly acid urine, and certain others only in alkaline urine. Without doubt other conditions are of importance, such as, perhaps, retention of urine.

Müller calls attention to the great frequency with which calculi form after severe spinal injuries. He cites the records of the Halle Surgical Clinic, which show that in 8 cases of patients who suffered from severe injuries of the spine every one upon whom autopsy was performed suffered from calculi. The urine of such a patient within six or seven weeks after the injury of the spine contains albumin and great numbers of microbes of different sorts, but especially bacterium coli. This fact suggests that clumps of bacteria or necrotic epithelial cells may be the nucleus of a calculus. On the other hand, these bacteria are found throughout the urinary tract; and although the necrotic processes are most pronounced in the bladder, the calculi are formed only in the kidney. Charcot explains this by saying that there is an acute necrotic inflammation of the kidney as the direct result of the spinal injury. The inflammation of the kidney was formerly looked upon as secondary to a cystitis. Stolper believes that the hyperæmia of the paralyzed portions of the body produces a relative anæmia of the kidneys, and in consequence an increased destruction of epithelial cells which acts as a favorable factor in the formation of renal calculi. Stagnation in the urinary stream is another favoring influence.

There are other factors to be considered in connection with calculous disease. It is to a high degree an endemic malady, and differs very much in different geographical districts. In Alsace, along the

Rhine, along the Moselle, in Holstein, and in many other regions in which goitre and cretinism are common, calculi are rare; while in England, Hungary, and certain parts of Austria, Russia, and Turkey they are common. That they are common in Egypt and other tropical countries has been stated, and the reason therefor given.

Customs and habits of life are not without their influence. It is interesting to notice that in certain countries inhabited by two or more races, the members of one race will suffer from calculi while others will be relatively free. Thus, Keelan states that calculous disease occurs in India more often among the Mohammedans than it does among the devotees of the other religions, a fact which he explains by the custom the Mohammedans have from early childhood of squatting down to urinate. He says that it is impossible to empty the bladder completely in this position, and that this fact has a great influence upon the formation of urinary calculi.

The two periods of life in which calculi are most common are before puberty and after the fortieth year. Civiale found that 45 per cent. of 5900 cases of calculus occurred in children. Children who are less than five years old are especially subject to this affection. In different countries the relative frequency and occurrence at different ages vary more or less.

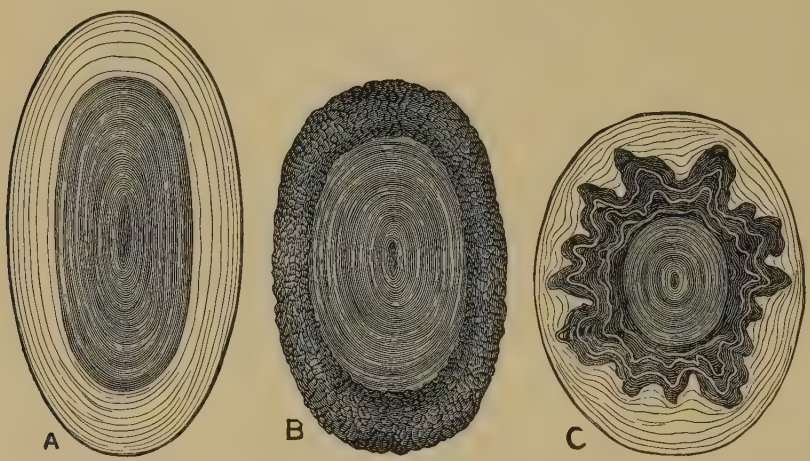
Calculi occur much more frequently in males than in females. The percentages are given as 95 to 5. One reason for this great difference is the ease with which a small stone can pass from the female bladder on account of the relatively wide and short urethra.

Calculi in children are found more frequently among the poorer classes than in those who are well-to-do, perhaps on account of an insufficient or improper diet; for example, the substitution of all sorts of mixtures in the place of milk, and the giving of too little fluid. Other articles of food and drink which have been supposed to have some bearing upon the development of calculi are wines, hard drinking-water, certain vegetables which contain calcium oxalate, etc.; but it is doubtful if such causes are important, as they exist both in regions where calculi are numerous as well as in those in which they are scarce. In the later years of life rich food and a lack of muscular exercise are justly considered to favor the formation of calculi.

Method of Origin, Form, and Chemical Composition of Calculi.—While calculi may be found in any part of the urinary passages, they originate only in the kidneys or their pelves, or in the bladder. A fine granular deposit of urates is found in the kidneys of the newborn in about 47 per cent. of the cases. These uric acid "infarcts," as they are called, disappear in a short time. Larger concretions are designated "renal sand"; or, if the particles are still larger, as large, perhaps, as pin-heads, they may be spoken of as "renal gravel," while the term "stone" is usually reserved for a calculus too large to pass through the ureter. A stone may reach enormous proportions in either the renal pelvis or the bladder.

Calculi may be divided into three groups, according to their composition. The stones of the first group are made up of uric acid, or urates; those of the second group, of oxalates; and those of the third group, of the phosphates. Calculi composed of cystin or xanthoxyd, calcium carbonate, and some other substances, are rarely found.

Fig. 120.



Calculi of which the nuclei (at least) were formed in the kidney; *a*, nucleus of uric acid, periphery of phosphates; *b*, nucleus of uric acid, periphery of calcium oxalate; *c*, nucleus of uric acid, middle layer of calcium oxalate, and periphery of phosphates.

1. Uric acid calculi are the commonest of all, especially in childhood. Such a calculus may be pure, or mixed with urates or with calcic oxalate, or covered with a deposit of phosphates. Its color is pale yellow, yellowish brown, or reddish brown, or, less often, greenish gray. Its surface is smooth or finely granular, its consistence very hard, and its specific gravity about 1.5. Its cut surface has an even, amorphous appearance or a concentric arrangement. If two or more stones are present, they will show facets where they are in contact. A single stone may reach a great size.

2. A calculus made up of calcium oxalate is often mixed with uric acid, urates, or calcium carbonate. It is almost as common as a uric acid calculus, and ordinarily exists alone, and does not exceed in size a hazelnut. It is yellowish or reddish, and is often stained dark brown or black by altered blood-pigment. It is the hardest variety of urinary calculus, and has the greatest specific gravity. Its cut section is marked by wavy, concentric lines. On account of the rough surface of these calculi they have been spoken of as mulberry stones.

3. Triple phosphate calculi (ammoniomagnesium and calcium phosphate) are also common. They develop in alkaline urine as the result of inflammatory processes in the urinary tract. They are white or dark gray. They have a low specific gravity, and a smooth or

slightly granular surface. The cut section appears lamellated or amorphous. The consistence varies according to the relative amounts of calcium and magnesium salts present. They are usually single and may reach a great size.

A calculus containing urate of ammonium is rarely seen. When it does occur, it is almost always composed in part of uric acid, calcium oxalate, or calcium phosphate. Such a calculus is slaty gray or clay colored, smooth or granular, friable, and of slight specific gravity. These stones are found in alkaline urine and are usually single.

Calculi composed of phosphates of ammonium and magnesium are rarely pure, but contain layers of other substances. Their size and specific gravity are variable, and in form they are irregularly rounded. When dried they are whitish, and their cut sections appear either crystalline or jagged, but not lamellated. They form in alkaline urine and are easily broken.

A calculus containing calcium phosphate usually contains also ammoniomagnesium phosphate. It is apt to be small, of variable specific gravity, and is made up of amorphous particles mixed with mucus. Its color is grayish and its consistence very soft. It forms in alkaline urine.

Calculi of calcium carbonate are almost always mixed with calcium oxalate and phosphate. They occur more frequently in the kidney than in the bladder, are sometimes multiple, and are not larger than a small nut. They are white, yellowish or darker, and show on cut section a wavy, lamellated appearance with one or more nuclei. They are hard and develop in acid urine.

Cystin calculi are rare. They may be pure or mixed with other substances. They are more apt to be single than multiple, and are usually small, rounded, smooth, yellowish or white. They are soft and easily broken, and on cut section show a white, lamellated, waxy appearance. They occur in acid urine.

Xanthin calculi are very rare, brownish or reddish stones, with a smooth surface, and lamellated structure looking on cut section like wax. They are about as hard as uric acid calculi and develop in acid urine.

There are two recorded instances of the formation of indigo calculi.

For qualitative chemical analysis of a calculus one should select small particles which appear to be uniform throughout rather than to use some of the dust which the saw leaves in cutting through the stone. A bit as large as the head of a pin is placed on an object-glass or in a small watch-glass.

Urates are best recognized by the murexid test. If a fragment of a uratic calculus is pulverized and mixed with a few drops of sulphuric acid, alloxan is found. This when dried and mixed with a drop of ammonia gives the purple-red color of murexid.

Ultzmann's table for the examination of a calculus is as follows :

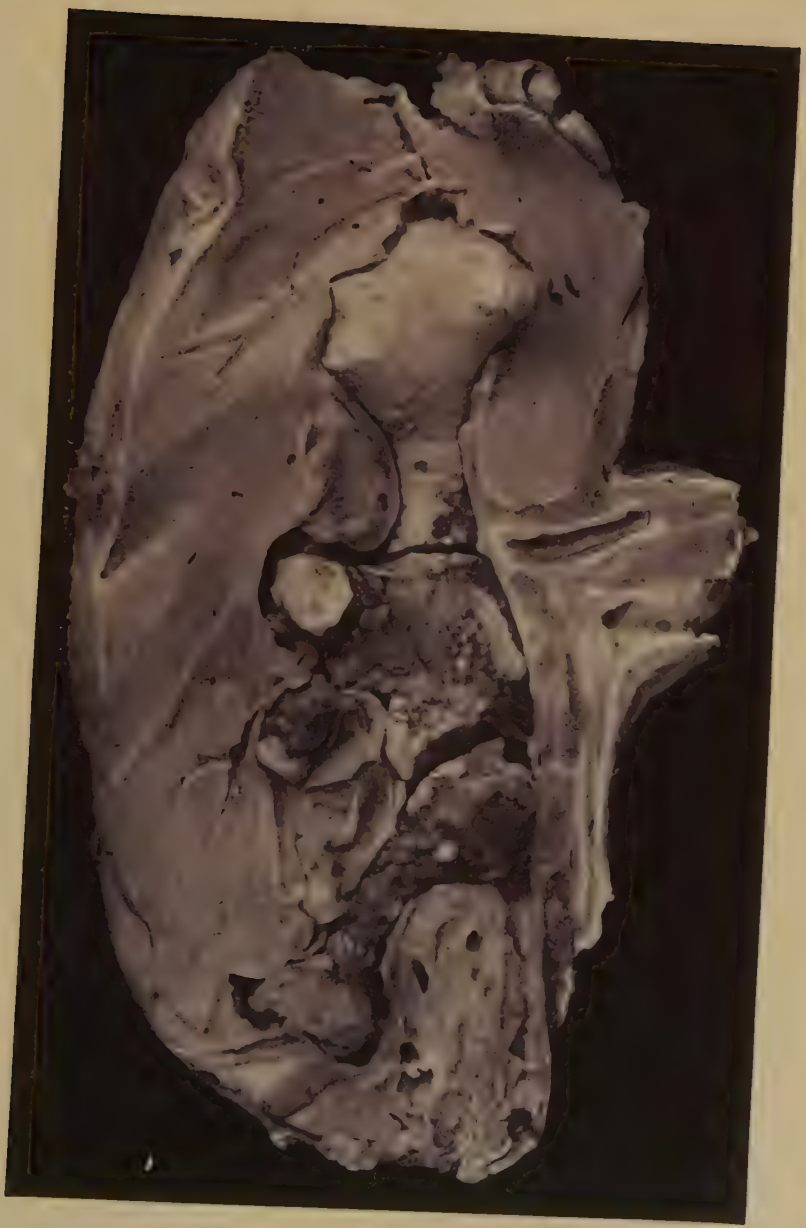
Combustible.	The powder burns without a visible flame, and without odor.	The murexid test with ammonia is purple red, with caustic potash purple violet.	Uric acid and urates.
		The murexid test with ammonia is yellow, with caustic potash orange.	Xanthin.
	The powder burns with a feeble blue flame, and with an odor like burning sulphur and fat, or asafœtida.		Cystin.
Non-combustible.	The powder effervesces with hydrochloric acid.		Calcium carbonate.
	The powder does not effervesce with hydrochloric acid.	The powder effervesces after it is heated.	Calcium oxalate.
		The powder does not effervesce after it is heated.	Earthy phosphates.

Pathological Anatomy.—While calculi may form in any part of the kidney, the renal calices and the renal pelvis are the usual sites of their formation. The size and shape of a calculus are influenced to a great extent by the cavity in which it develops. A calculus forming in the renal parenchyma is small, and has the shape of a bean or pea. If it develops in the wider calices, it has a rounded shape and larger form; and if it develops in the ureter, it has a long, cylindrical form like a date-seed or even longer. A single calculus developing in the pelvis of the kidney may be moulded by this cavity, whereas if several calculi are present the sides which are in contact will be flattened or facetted. If a calculus occupies the renal pelvis and extends into the calices, it will have an irregular shape and may reach an enormous size, possibly weighing two pounds or more. Instances have been reported of 150 and 200 calculi in a renal pelvis. These high figures represent rare exceptions. Ordinarily the calculi are few in number and of small size. In about one-half of the cases the kidney has a single stone, and in about one-third of the cases more than two stones. Both kidneys may be affected simultaneously, but this is not usually the case.

Besides the well-developed calculi there may also be incrustation or impregnation of ulcerating and necrotic portions of the surrounding tissue. Such incrustations are often of a different character than that of the original calculus. They usually develop after a secondary infection of the kidney has taken place and the urine has become alkaline and contains pus. The salts which are deposited in the tissues will therefore be calcium phosphate or ammoniomagnesium phosphate. The incrustation of fragments of renal tissue may lead to the formation of hollow calculi containing pus or other fluid, and multitudes of bacteria.

Every calculus irritates the tissue with which it comes into contact, and it may produce chronic inflammatory and degenerative changes in the renal parenchyma. While these changes are comparatively slight as long as the urine remains aseptic, they may result in suppurative

PLATE VIII.



Renal Calculus; Kidney shown in Cross-section. (Taylor.)

pyelitis and nephritis as soon as the urine becomes infected and undergoes alkaline fermentation. If the urine remains aseptic, the endarteritis and periarteritis will stimulate the connective tissue between the tubules to an abnormal growth, which will strangulate the tubules and cause them to atrophy. Every renal calculus produces a certain amount of urinary obstruction, and this exerts a destructive influence greater or less according to the position of the stone. The dilated tubules may be destroyed, or the renal calices and the renal pelvis may dilate more and more until the kidney is transformed into a fibrous sac, as was described in the chapter on Uronephrosis. Sometimes the kidney simply atrophies and shrinks without dilatation. This process may go on until the whole kidney is not larger than an almond. A third possibility of an aseptic calculus is that the stone may lie for an indefinite period in the kidney without producing much reaction except a mild interstitial nephritis in its immediate vicinity.

The common result of calculus in the kidney is a secondary infection followed by pyelitis and nephritis. The suppuration and the irritation due to the calculus will then work together to destroy the renal parenchyma, aided from time to time by the obstruction of the urine. This is a condition of affairs described in the previous chapter, excepting that the calculus by its constant presence intensifies the inflammatory processes and hastens their termination, and often produces hemorrhages meanwhile. As a result the kidney will change into a great loculated abscess cavity, with stones in the various loculi surrounded by pus and ulcerating and necrotic renal tissue. Such a pyonephrosis may finally break externally, or it may become a complete pyonephrosis if a calculus blocks the ureter.

This secondary infection may occur from the blood, or from the lower urinary passages. The latter is considered its usual source; whether justly or not, is not definitely determined. Gonorrhœa plays an important part in both sexes.

Suppurative inflammation of the kidney complicating calculus often extends to the fatty capsule, or, breaking through this, forms a large perinephritic abscess. Such an abscess may break externally or into the intestine. The calculus may thus be discharged and a permanent cure result. This is, however, a rare occurrence. In most instances suppuration continues until it is terminated artificially or ends in death.

Another rare termination is the development of a stone together with the atrophy of the parenchymatous tissue, until nothing is left but a fibrous capsule with a central cavity containing the calculus.

If a urine previously acid becomes alkaline after the entrance of infection, the uric acid or calcium oxalate calculus will become coated with calcium phosphate or triple phosphates, and rapidly increase in size. The nucleus and outer layers of such calculi will therefore indicate quite different conditions of the kidney at the time of their formation.

A long-continued inflammatory process in one kidney is certain to have an influence upon the other; even a simple aseptic growth of connective tissue with atrophy of the parenchyma is not without its effect. It will at least produce the hypertrophic changes which have been dscribed as following loss of renal tissue. This compensatory hypertrophy is only possible in a healthy kidney. In calculous nephritis the health of the second kidney is already injured; for as a rule the individual shows a disposition to calculous formation which will have affected the second kidney even though no favoring circumstances may have produced there a calculus.

If infection is added to a calculous nephritis, and suppuration develops, the injury of the second kidney will be far greater. The septic pus and alkaline urine will forthwith infect the ureter and bladder if they were not previously infected. The patient is then subjected to the risk of an ascending infective process from the bladder to the second kidney. Statistics collected by Legneu show how frequently the second kidney is infected. He found that in 76 cases of calculous nephritis the second kidney was free from calculus only 38 times, while in only 4 instances was the second kidney absolutely healthy. In a fifth case there was no second kidney. Thus, in 50 per cent. of the cases the disease of the second kidney was the same as that of the first, while in the remaining cases the second kidney was affected by sclerosis or suppuration, or hypertrophy, or atrophy, or cystic degeneration, or some combination of these processes. If the suppuration of the first kidney continues a long time, the second one is apt to show the signs of amyloid degeneration.

Symptoms.—There are no methods of examination which directly prove the presence of stone in the kidney except radiography, palpation, and the passage of a ureteral probe. Palpation is only possible if the stone is very large or if several are present. There are, however, several symptoms which have a relative importance in the establishment of the diagnosis:

1. The pain which is produced by a renal calculus varies exceedingly according to whether the stone is movable or is fixed in the renal parenchyma; whether from its position it obstructs the urine; whether it is able to enter the ureter; and, finally, whether the inflammatory process is aseptic or suppurative.

An aseptic calculus which lies quietly causes little disturbance, so that it cannot be at all noticed, or there may be a slight feeling of pressure, or an indefinite feeling that something is not quite normal. This feeling of pressure is not necessarily increased by some sudden or jarring motion, and yet it may change to an intense pain if the patient runs, jumps, rides, or travels over a rough road. In this respect a renal calculus may produce symptoms similar to those of a vesical calculus. Sometimes there is a continuous, though not very severe, pain, which is increased either by direct pressure from in front

against the hilus of the kidney or by strong percussion over the kidney in the lumbar region.

The pains above described are usually caused by larger calculi. Pains which have been long considered pathognomonic of renal calculus are of a colicky nature, very intense, and coming on in distinct attacks. This renal colic is associated with the passage of a small stone through the ureter, and ceases the moment the stone enters the bladder. The intense pain is felt in the lumbar region and along the course of the ureter, and may also extend toward the bladder, the testicle, the head of the penis, the inner surface of the thigh, the buttocks, the abdominal wall, stomach, and other abdominal organs. Such an attack may come on suddenly, even during sleep, and may be so intense that the strongest person breaks down and trembles, and becomes covered with cold sweat, and even loses consciousness, while the temperature and respiratory rhythm rise, and the pulse becomes small and rapid. Nausea and vomiting may also be produced. The patient strains violently to pass water, but produces only a few drops of dark, perhaps bloody urine; or, if he suffers from pyelonephritis, the urine passed will be mixed with pus, blood, and mucus, and will cause intense burning of the urethra. In other cases on account of complete unilateral obstruction of the ureter by the stone only urine from the healthy kidney enters the bladder, and that passed from the urethra will be found upon examination to be normal.

If the attack is caused by the passage of gravel, it is of a milder character. After it is over, a small concretion will usually be passed during the first urination.

Such an attack would be characteristic if it occurred only when a foreign body passes through the ureter. Unfortunately this is not the case. It is due rather, as has been said, to any cause which produces an increased tension of the capsule of the kidney. This may be brought about by an acute inflammatory congestion, by a venous distention, as in renal strangulation, or by an obstruction to the urine in the renal pelvis of whatever nature, and whether due to a small stone in the ureter or to a larger one obstructing its mouth, or to a kinking of the ureter, or to the formation of a valve which closes its mouth. Hence these attacks of pain are found in a great variety of conditions, such as intermittent uronephrosis, renal tuberculosis, tumors, and acute congestion associated with a contracted capsule, as well as in calculous nephritis. If the attack does not terminate by the passage of a stone or fragment of a stone into the bladder, or if the presence of a stone cannot be proved in other ways, one cannot say simply from the attack of pain what the diagnosis may be.

2. A second and very important symptom is hemorrhage. This may also appear in a variety of forms. The blood may be so small in amount that it can only be recognized by means of a microscope. Israel mentions this as one of the common symptoms of calculous nephritis. Such a urine, otherwise clear, will show a slight cloudy

sediment in which a few red blood-corpuscles can be demonstrated. Such an examination will occasionally yield a negative result, but repeated examinations will not do so unless the patient is confined to bed. Active motions naturally increase the bleeding.

Sometimes the hemorrhage is much greater in amount, and may even become dangerous. This is usually the result of overexertion, but may occur without it. There may be repeated hemorrhages without other symptoms sufficiently well marked to enable the surgeon to make a diagnosis. Indeed, death from hemorrhage of this character is reported by Schede, who found at autopsy a mulberry stone in the pelvis of the kidney not larger than the pit of a cherry. The stone had eroded one of the chief branches of the renal artery.

Hemorrhage is not pathognomonic of calculus. It occurs in connection with tuberculosis, with tumors, and also in the condition called renal hæmophilia, which will be spoken of later.

Neither is enlargement of the kidney nor pyuria pathognomonic of renal calculus, since both of these symptoms may be due to several other causes.

3. Another important symptom of renal calculus is anuria. It has been mentioned that a stone in passing through a ureter may completely obstruct the flow of urine from the corresponding kidney.

The condition is bad when the effect of the obstruction is to stop the excretion of urine from the affected kidney, and the condition is still more serious when by a reflex action the excretion of urine from both kidneys ceases. This is spoken of as reflex anuria. The excretion of urine is entirely suspended, and death will follow from uræmia in a short time unless relief is afforded.

If a ureter is completely obstructed, the excretion of urine from the corresponding kidney is very much lessened. This diminution is not usually shown until the urine collects in the renal pelvis under a considerable pressure. This pressure extends to the renal tubules and makes the kidney anæmic. This increase of pressure may succeed in forcing the calculus through the ureter and so bring about a spontaneous cure. There are other cases in which after a stone has blocked the ureter for several days only a few drops of urine have been found in the renal pelvis. Under such circumstances the force which should drive the calculus through the ureter is wanting and a spontaneous cure is not to be expected.

It has been denied that obstruction in one ureter can stop the excretion of urine from the opposite kidney. The lack of urine has been explained by saying that the opposite kidney is diseased, or that it also contains a calculus, so that both ureters are accidentally obstructed at the same time. These explanations are mere theories, and there are enough observations of bilateral anuria due to unilateral obstruction of urine in order to establish the reflex theory beyond a reasonable doubt.

This reflex anuria occurs not only in connection with calculous

nephritis, but also after obstruction of the urine from other causes or after renal injury. Whether it can be caused by nervous impulses due to other organs is not yet clear, but it is well known that there is a hysteric anuria apart from the anuria which may gradually develop as a result of repeated vomiting. Such an anuria never lasts more than ten days.

It is self-evident that complete anuria may follow the simultaneous obstruction of both ureters, or the obstruction of one ureter in case the other kidney is wanting, so that one ought never to be content with the diagnosis of reflex anuria simply because no urine enters the bladder when one ureter is obstructed. Such a mistake has been made only to be corrected at autopsy.

Israel has done much to explain the physiological incidents of reflex anuria. He says that the excretion of the urine is dependent upon a vasomotor contraction or dilatation of the renal passages, and that this is subject to the influence of the nervous system. Irritation of the nerves entering the hilus may produce anæmia of the kidney, with anuria, while extirpation of the renal nerves is followed by marked hypertrophy of the kidney and increased excretion of urine. Stimulation of the vasomotor centres in the medulla oblongata is capable of producing anuria. The same may be caused by an excess of carbonic acid in the blood, or it may be produced by irritation of the peripheral ends of the sensory nerves. Further proof of the limitation of renal activity by nervous means is shown by the oliguria and anuria which often accompany hysteria. Charcot mentions such anuria which lasted eleven days. The administration of chloroform relieved the vascular contraction and re-established the urinary flow. Other writers have mentioned reflex anuria due to disease of the female genitals, the anuria disappearing as the patient recovered from the pelvic trouble. Certainly, some of the cases of anuria after extirpation or injury of one kidney are to be explained in this manner. Reflex anuria may be regarded as proved; but it is not at present possible to explain why it does not occur every time that the apparent causes are the same.

4. Calculus in the kidney can produce symptoms of vesical irritation, with urgency and frequency of micturition and pain in the urethra at the close of the act, equally well when cystitis exists or when the bladder is perfectly normal.

Morgagni points out that inflammation of the kidney may produce the same symptoms as inflammation of the bladder, and Rovsing admits that the use of the cystoscope has shown him that in one-half the cases formerly diagnosticated by him as cystitis no inflammation of the bladder exists.

Diagnosis.—Enough has been said to show that the diagnosis of calculous nephritis is by no means easy, for the symptoms caused by stone may be the same as those caused by other diseases of the kidney. An exception must be made in case a stone is palpated, or is shown in a

radiograph (Fig. 121), or is touched by a probe passed through the ureter. But direct diagnosis by one of these means is possible only in

Fig. 121.

Röntgen-ray picture of phosphatic calculi in both kidneys. (Albarran.)

a limited number of cases. Furthermore, the symptoms of nephrolithiasis resemble those of diseases of other organs than the kidney. For example, it may be very difficult to say definitely whether an attack

of colic is due to a biliary or renal calculus. Even the pain which accompanies ulcer of the stomach or duodenum may be mistaken for that due to renal calculus. On the other hand, pain due to renal calculus may be referred to other organs, so that the diagnostician supposes them to be diseased instead of the kidney. Finally, a calculus may remain for a long time without giving noticeable symptoms.

Pain in the region of the kidney and bladder, a hæmaturia and pyuria occurring without apparent cause, should excite the surgeon's suspicion. If the patient is of a gouty or calculous diathesis, and still more if his urine often contains uric acid, red blood-corpuscles, or urates, or possibly gravel, the suspicion of renal calculus is much stronger. It is still further strengthened by attacks of colic, but even then the diagnosis is not positive.

In order to establish a diagnosis of renal calculus the following steps should be taken:

1. The history should show an inherited tendency to disease, any previous attacks of gout which the patient himself may have had, the existence of long-continued dull pain in the lumbar region, increased by severe exertion, and the extension of the pain in any given direction; attacks of renal colic, passage of gravel or small stones in the urine; increased desire to micturate; the passage of urine mixed with blood and pus; sudden interruption of the urinary flow; and a sudden alternation between the combination of cloudy or purulent and perfectly clear, light urine (due to temporary obstruction of the ureter on the affected side).

2. The second step is the physical examination of the patient. If one or two stones are present in the kidney, unaccompanied by infection or suppuration, the organ need not be enlarged nor palpable. The pain caused by deep pressure will under such circumstances be slight, and even strong percussion of the back in the lumbar region may not produce the pain described by books as so characteristic. In other cases the kidney will be found so tender that not only strong percussion, but even the slightest pressure, will produce violent pains. While pain on pressure is a symptom which is rarely wanting, it cannot be considered characteristic. If the calculus has brought about suppuration, or retention of urine in the renal pelvis, or both, the kidney will be more or less enlarged, and more or less tender according to the tension of the retained fluid. If the kidney is situated low down, or if the pelvis is much dilated, it may be possible to feel a stone in the renal pelvis bimanually; or if several are present, they may be made to rub one upon the other with a characteristic creaking.

3. The third step in making a diagnosis is the examination of the urine. So long as the urine of the diseased kidney remains aseptic and the stone is so situated that it need not be much moved, the examination of the urine may be completely negative. There may be no increased deposit of urates to indicate an abnormal composition of urine, nor casts to point to a local parenchymatous inflammation, nor a

mixture of blood due to local mechanical inflammation. Schede observed a case in which during a period of five years dull pains, increasing every three or four weeks to severe attacks, were the only symptoms of a stone as large as a cherry-pit in the parenchyma. As a rule the urine of this patient was free from abnormal elements. Occasionally it contained a little blood. In such a case the daily examination of the urine is absolutely necessary. If one finds either constantly or occasionally, on microscopical examination, a few bleached red blood-cells and an occasional cast, the possible diagnosis of renal calculus is much strengthened. Single large hemorrhages may be due to calculus, or to tumors, or tuberculosis, or to hemorrhagic nephritis. The constant presence of minute quantities of blood in the urine is especially noticeable in calculous nephritis and hemorrhagic nephritis.

The bacteriological examination of the urine, drawn with a catheter in order to avoid contamination with the smegma bacillus, should be made in order to prove the presence or absence of the tubercle bacillus.

If the kidney and the pelvis of the kidney are infected, pus flows into the bladder, making the urine quite like that found in cystitis, and producing physical symptoms similar to those of cystitis, namely, tenesmus and loss of vesical capacity. The urine will still contain a little blood, but its condition is no more characteristic than without the pus. The differential diagnosis from cystitis is easily made by means of the cystoscope. The mucous membrane of the bladder is not ruptured nor swollen, nor does it appear inflamed. Examination of the mouth of the ureter will reveal the exit from it of cloudy, purulent, or bloody urine. Under certain circumstances such urine will come from both ureters. Pressure on the affected kidney will increase the flow of pus.

It must not be assumed that the flow of cloudy or bloody urine from one ureter and of clear urine from the other is sufficient proof of the presence of a stone; it merely proves the existence of pyonephrosis or pyelonephritis, nothing more. It is true that this condition often follows calculus formation, but is by no means confined to it.

The passage of a probe from the bladder through the ureter is a method of examination hitherto seldom employed. Kelly and Pawlik have shown that in the female a probe can be passed without difficulty into the renal pelvis, and the presence of a calculus demonstrated by this means. In the case of man the probe must be an elastic one, and even if it reaches the kidney one may not be successful in feeling the calculus. Such a probe should have a metal tip and be capable of introduction through a ureteral cystoscope.

Examination with the *x*-ray under certain circumstances gives a clear demonstration of the presence of renal calculus. The different kinds of calculi give different degrees of shadow in a radiograph. Thus, a calculus composed of oxalate gives a very sharp shadow, one composed of urates or uric acid a less sharp shadow, while calculi composed of soft phosphates give almost no shadow, in this respect

resembling biliary calculi. Ringel showed that these rules hold true whether the calculi are laid directly on the photographic plate or are placed in the kidney of the cadaver. In attempting to radiograph calculi in the living subject one has to overcome certain other difficulties. The motions of respiration tend to make the lines of the picture less distinct. Furthermore, the pelvis of the kidney in which the calculi are situated is usually more or less distended with urine, pus, or blood. The parenchyma of the kidney gives a considerable shadow, and in very stout people the increased bulk of the soft parts adds to the difficulties to be overcome. On account of these difficulties Ringel concluded that radiographs of renal calculi, except in the case of oxalates, are of little value. Further experiments have proved this view to be too pessimistic. Wagner succeeded in obtaining a clear radiograph of a phosphatic calculus in the kidney, and in 8 cases of calculi in the urinary bladder composed either of uric acid or phosphates. His conclusion was that calculi composed of uric acid give the least distinct shadow of any. Other observers have since reported many successes equally encouraging.

A part of the difference in the results obtained is perhaps due to the fact that some calculi composed chiefly of uric acid contain small traces of oxalates and other substances capable of giving a more distinct shadow. But the greater part of the success of later experimenters is doubtless due to the improvement in the technic. Leonard lays especial stress upon the use of "soft" tubes in order to bring out slight differences in the density of the different tissues. He succeeded not only in obtaining radiographs of all kinds of renal calculi, but his pictures show so clearly the outline of the kidney itself that one can tell with certainty whether a second kidney exists or not. The results of his radiographs have been repeatedly verified by operation. Albert-Schönberg presented at the German Surgical Congress of 1901 the results of his concentration of the *x*-rays by means of lead plates. With this apparatus he was able to obtain sharp pictures of very small renal calculi. The technic of radiography has already formed the subject of several works, so that it is unnecessary in this space to go further into details.

The sum of the matter is that the existence of calculus in the kidney or its pelvis may be demonstrated in favorable circumstances by probing the renal pelvis, or by palpation, or by radiography. These methods of examination are often difficult, and are sometimes so uncertain that unless they yield a positive result they are of little value, since it is unsafe to infer from a negative result that a calculus is not present.

Treatment.—The object of treatment is, in the first place, to remove a formed calculus; in the second place, to limit the injury thereby produced as far as possible; and in the third place, to protect the patient against a return of the trouble. The attempts to absorb urinary calculi by internal medications are almost as old as the art of medicine. After the nature of the different forms of renal calculi was understood,

it was hoped to absorb oxalic and uric acid calculi by alkalies and phosphatic calculi by acids. Both attempts have invariably failed. Reagents which in a test-glass dissolve the stone most readily, such as lithium carbonate and piperazin, lose this power entirely when administered internally. Nevertheless it is rational to reduce the excessive acid of a uric acid urine by the administration of alkalies, thus enabling the urine to keep in solution the uric acid and urates which are present. One should not push this treatment so far that the urine becomes alkaline lest a precipitation of phosphates be the result.

Mendelsohn recommends as a solvent urocedin, a substance made from sodium and lithium citrate, sodium sulphate, and sodium chloride. Urocedin is a feebly acid salt which is only slightly affected by the hydrochloric acid of the stomach. It is administered in doses of 0.5 gramme (7.5 grains) several times a day, for a period of several weeks. If given in such quantities it may make the urine alkaline, but careful attention to the dose will enable one to keep the urine either neutral or feebly acid. Nicolaier and Casper recommend the use of urotropin tablets dissolved in much water, in amounts varying from 0.5 to 4 grammes (7 to 60 grains) daily. This substance is said to split in the body into formaldehyde and ammonia. It is a powerful antiseptic, and will also dissolve uric acid and uratic calculi, and benefit patients suffering from phosphaturia. This treatment may be advantageously combined with the use of mineral waters (Fachinger, Salvator, etc.), some of which have the effect of making the urine alkaline, and all of which by diluting the urine increase its ability to hold the uric acid in solution. The advantage of the latter point is so great that Rovsing advocates the daily use of large quantities of boiled water, which he says acts even better than mineral waters as a diluent of the urine. The flow of urine will thereby be so increased and strengthened that the gravel and sand will be washed from the kidney and passed through the lower urinary channels.

Herrmann recommends that a patient take from 50 to 100 grammes (1.5 to 3 ounces) of pure glycerin at one dose. Some of it will appear unchanged in the urine. It has only a slight solvent action upon urinary calculi, and its good effect is partly due to the great quantities of water which the patient drinks, and partly to the fact that in mixing with the urine it makes the passages slippery and thus facilitates the washing out of small calculi. Be that as it may, two or three hours after the glycerin is taken pains will be felt in the region of the affected kidney, and a little later a considerable quantity of sand and small calculi will be passed.

The measures thus far spoken of have an undoubted value in preventing the deposition of urinary sediments and facilitating their passage in the urinary stream. But none of these remedies will actually dissolve calculi already formed. These can only be removed by the knife of the surgeon.

The treatment of renal calculi as practised by the older surgeons

was conservative in the extreme. Hippocrates advocated the incision of perinephritic abscesses with or without the extraction of the calculi which caused them. This principle of practice held good until very recent times. From the sixteenth to the seventeenth century many surgeons discussed the question whether it was not possible to remove the calculus from a pyonephrotic sac before the abscess broke through the kidney. But the question remained a purely theoretical one, for it was finally decided to adhere to the principles of treatment advocated by Hippocrates. In the first half of the nineteenth century the question was again discussed; and finally, in 1870, several men opened the kidney in the search for calculi, but failed to find them. This naturally discouraged such an operation.

Simon believed that the incision of the renal parenchyma would be followed by dangerous or fatal hemorrhage, and that the necessary separation of the fatty capsule would result in gangrene or suppuration. He therefore drew the conclusion which to-day seems most remarkable, that incision of a pyonephrotic sac and removal of a calculus are justifiable if the renal parenchyma has all been destroyed; while if the kidney containing a calculus has not reached this stage, it should be completely extirpated. Accordingly, in 1871, he removed such a kidney from a woman aged thirty, after having demonstrated by urine collected during renal attacks that a second kidney existed and was functionally active. Simon was unable to feel any calculi in the pelvis of the kidney after it was exposed, and did not then know until he had removed the organ whether his diagnosis was right or not. The kidney was found, however, to contain about twenty small stones. The patient did well for about three weeks, but finally died of septic peritonitis. He advised that the diagnosis be established by acupuncture before the removal of such a kidney.

In 1880 Czerny removed a calculous kidney and the patient recovered. In the same year Morris pointed out the correct method of treatment of such cases by removing the stone, which in his case weighed 31 grammes, and leaving the kidney relatively uninjured. His patient recovered and eventually the fistula healed. Soon afterward other operators removed calculi through incisions directly into the renal pelvis or into the upper portion of the ureter, and the new treatment of renal calculus was fully established. In 1888 Le Dentu advocated the suture of the divided renal parenchyma as the surest method of checking a hemorrhage, and in the following year Tuffier showed that the incision along the convex border of the kidney—the so-called autopsy incision—is followed by the least hemorrhage and does less damage to the arterial system. It has since been learned that this incision should be slightly farther back, as was pointed out in the section on the Anatomy of the Kidney.

The method of treatment generally employed to-day is removal of the stone rather than removal of the kidney. This should be the invariable rule in all cases in which there is no suppuration. If

suppuration has taken place, the surgeon will have to decide whether the advantage to the patient from the portion of the kidney which remains will outweigh the risk which it will entail if it is allowed to remain. In accordance with his decision of this question he will either remove the stone and drain the kidney, or extirpate the entire organ.

But before taking up the different methods of operation it is desirable to settle the question under what circumstances operation is indicated. The question is not so simple as it appears, for on the one hand there are cases of aseptic renal calculi which give rise to only slight symptoms, and yet one can never say with a certainty that such an apparently harmless calculus may not at any time become an extremely dangerous one. Every patient who has a renal calculus is constantly subjected to the risk of a reflex anuria or a sudden hemorrhage. Still, the operation for the removal of a stone is not always simple, so that it carries with it a certain degree of danger. In still other cases the uncertainty of the diagnosis will make it difficult to decide upon treatment. Perhaps a certain diagnosis may be impossible until the presence of a stone can be demonstrated by means of the *x*-ray. There have been numerous instances in which the kidney was exposed and even excised, and yet no stone was found.

An incision of a kidney which contains no stone need not necessarily cause much regret. Such a patient will undoubtedly have suffered renal attacks similar to those due to renal calculus, but due to some other cause, such as small tubercular foci, abscesses, tumors, abnormal position of the kidney, congestive cicatricial contraction, etc. These conditions, if present, may be revealed by the exposure and incision of the kidney, and it not infrequently happens that the operation relieves the patient of the attacks of renal pain. However, mistakes in diagnosis are never pleasant, and they may easily be avoided in this instance by a careful study of the answers given by Israel to the following questions:

1. Under what circumstances is it necessary to operate in order to save life? 2. Under what circumstances should operation be performed, even though there is no immediate danger to life as a whole, or to the life of the kidney? 3. When should a surgeon refrain from operating?

An absolute indication for immediate operation is the existence of calculous anuria due either to a stoppage of both ureters, or due to reflex action set up by stoppage of a single ureter, or due to absence of one kidney and the stoppage of the only existing ureter. It is true that complete anuria may continue for a certain length of time and then pass off as the renal calculus is spontaneously evacuated. But this hope must be abandoned if the pain moderates while the anuria continues, or if from the beginning there has been no pain. These signs will show that the increased tension in the renal pelvis has either passed over or did not exist, and under such circumstances results of operation are far better than those of purely expectant treatment.

Statistics collected by Morris in 1898 show that operation has given 51 per cent. of recoveries, and expectant treatment 20.8 per cent. It is beyond doubt that the percentage of recovery will be greater when operation is earlier decided upon.

This leads to the important question, How long is it safe to wait before operating? A person can withstand the effects of complete obstruction of urinary secretion for six or seven days before dying. Instances have been reported of life maintained for longer periods, and success following operation undertaken after the first week of anuria has been reported in a few instances. On the other hand, operation undertaken after the third day may be too late to save the patient. Thus the opinion previously held that operation should be performed after five days of anuria has been generally abandoned. After so long a period of anuria the renal epithelium will probably be so injured that it will never again be able perfectly to perform its functions. A better rule is not to wait more than forty-eight hours after anuria becomes total.

If only one kidney is affected, the operation indicated is plainly incision of the affected kidney. But what shall the surgeon do if there have been symptoms referable to both kidneys, and it is not clear whether the obstruction is bilateral or unilateral, and if unilateral on which side it exists? Sometimes the most recent attack of pain occurring immediately before the anuria developed will indicate which kidney should be opened. Still, anuria may develop without renal colic, and the patient when first seen may be already too comatose to give his previous history. Furthermore, Israel points out that the attack of pain preceding the anuria may be on the opposite side from that of the calculus which causes the obstruction. Direct examination will be of little service, since it is difficult to feel a kidney only slightly enlarged; and at any rate, if the kidney is enlarged, this may be the result of an old rather than a recent process. Even if the surgeon can feel a calculus in the ureter by examination through the vagina or rectum, he dare not conclude absolutely that the stone thus felt is the cause of the existing attack.

The general rule then is to make the incision in a kidney in which the most recent obstruction has occurred; and if this cannot be determined, to make the incision on the side in which according to the whole history there has been the least trouble. This is a rule which will occasionally lead a surgeon to open a kidney which contains no stones. However, though no stone is found, a simple incision into the kidney may lead to a renewal of its urinary excretion, as shown in a case reported by Vignard, although the calculous obstruction of the other kidney continued.

The most serious condition is an incision into the kidney which is already destroyed. Under such circumstances, if the condition of the patient permits it, an incision should be made, either at once or on the following day, into the opposite kidney, although, if the patient is

already uræmic, the incision of the second kidney offers little hope. Incision of the renal pelvis rather than the usual nephrotomy should be considered under such circumstances.

Acute infectious suppurative processes also demand immediate operation. The calculus may produce miliary processes in the kidney, or abscesses in the renal pelvis associated with chills, irregular fever, vomiting, dry tongue, renal colic, etc. Under such circumstances the risk of an acute toxic affection of the other kidney makes it necessary that the kidney first affected should be promptly opened.

A further indication for immediate operation and the removal of a calculus is the obstruction of the ureter. Naturally this condition is less severe if the kidney is not infected and the retention takes the form of uronephrosis rather than pyonephrosis; but even uronephrosis will ultimately destroy the renal parenchyma, so that it is far better to make an incision and extract the stone, a procedure which under such circumstances has little risk. In calculous pyonephritis the indication for operation is absolute.

Severe hemorrhage is also an indication for operation. Such a hemorrhage may rapidly terminate in death. It is true such is not often the case. It is then impossible to differentiate between hemorrhage due to calculus and that due to renal hæmophilia, tuberculosis, or to malignant new growths. The last two named conditions demand operation equally with renal calculus.

A further indication for operative treatment is given by attacks of intense pain, or such a constant and dull ache that a patient is glad to accept the risk of operation even though the calculus does not threaten his life, and the disease is running an aseptic course. No patients are more thankful for the relief afforded them than those in this condition.

If the kidney which contains a calculus has become infected, as is shown by the flow of cloudy, suppurative, or alkaline urine out of the ureter, operation is positively indicated in all cases even though there may not be much pain, and the general condition may not be much affected, for there is no reason to hope that the infection will subside and the kidney return to an aseptic condition. On the contrary, it is certain that the suppuration will continue and involve the whole organ, or result in its contraction. Another positive indication for operation is the presence of calculus of the ureter if made out by palpation through the vagina, or rectum, or by means of the probe.

The doubtful cases are those in which the stone is probably or certainly present, but in which infection exists, and in which the symptoms are either slight or wanting. In such a case there may have been a severe attack of pain which has passed over, leaving only a slight dull pain. Or there may have been severe hemorrhage which has passed by, leaving only a trace of blood in the urine, or a kidney which is slightly enlarged. These symptoms go to prove that the trouble has not been done away with, but is only quiescent. In such a case the diagnosis may be uncertain, and, besides, the patient may

remain in such a condition for a long time, possibly for years. On the other hand, a kidney may undergo gradual contraction, or there may be a sudden severe hemorrhage, or a complete obstruction of the ureter, or reflex anuria, etc.

In view of these facts most modern writers advocate operation under the conditions mentioned. Morris and Tuffier give the rule to operate in all cases as soon as diagnosis is established. Rovsing says that the dangers of waiting are greater than those of operation. Ransohoff says that one ought not to wait to be absolutely sure of the diagnosis, since operation under the circumstances has very little risk, as statistics show. He cites the records of 44 cases of nephrotomy under conditions similar to those mentioned. A calculus was not always found, but no patient died from the operation, and many were relieved of their symptoms. The mortality of nephrotomy for stone under aseptic conditions is given by Rovsing as 7 out of 115 cases, or about 6 per cent., a figure which compares most favorably with other major operations, and which will undoubtedly be reduced by further experience in renal surgery.

Statistics show that the percentage of mortality in nephrotomy is much greater when infection is present. Thus, Morris gives the mortality of nephrolithotomy in aseptic cases as 2.9 per cent., and in septic cases as 23.25 per cent.—that is, about eight times as great.

Side by side with the question of operation, one must consider the question of the possible recurrence of the trouble. Perhaps the time is too short since renal calculi have been removed by operation to permit a correct estimate of their probable recurrence. But it appears to be true that suitable dietetic measures will almost certainly prevent the formation of acid calculi as soon as attention has been directed to the necessity for such strict rules of life. However, even if this were not the case, the fear of recurrence would be no reason for withholding from the patient the relief afforded him by the removal of the already existing calculus.

If from time to time small calculi are passed naturally, and between the periods of renal colic thereby caused the patient feels perfectly well, it is safe to assume that no large calculus remains permanently in the kidney, although a disposition to the formation of calculi exists. Under such circumstances an operation is obviously useless, and relief is to be looked for from dietetic treatment.

Method of Operation.—Two incisions are possible for the extraction of a renal calculus. The cut may be made through the parenchyma of the kidney—nephrotomy; or it may be made through the pelvis of the kidney—pyelotomy. At first glance, the latter method appears to be the simpler and more direct in case the calculus is situated in the renal pelvis. But it has certain disadvantages which overshadow these apparent advantages. Under normal conditions, or conditions which approach the normal, it is well-nigh impossible to explore the kidney and detect a small calculus in its substance by means of the finger passed through an incision made directly into

the renal pelvis. On the other hand, it is difficult through such an incision to remove large stones, especially if they have taken on some of the branching shape of the pelvis and calices. Thus, when the stone is removed entire, or when it is first crushed and then removed, the edges of the wound are apt to be bruised and torn, so that union by first intention is rendered less likely. If the kidney is already infected and drainage of its pelvis is desired, the direct opening into the pelvis is much more likely to be obscured by the soft parts of the body than is an opening made into the pelvis through the posterior portion of the kidney. Accordingly, closure of the pelvic wound by a sort of Lembert suture facilitates healing by first intention. It is also true that an incision made through the parenchyma of the kidney destroys the renal tissue immediately adjacent to the wound. Nevertheless, the advantages of accurate examination of the kidney and the easy escape of urine and other fluids give the preference almost invariably to nephrolithotomy rather than to pyelotomy.

The typical operation is carried out as follows : The kidney is freed, isolated, and luxated. The surgeon should be careful to make the dissection between the fatty capsule and the fibrous capsule, avoiding as far as possible any injury of the latter. The ureter is next separated from the rest of the hilus, and all the vessels are constricted in a mass by a thin rubber tube, the ends of which are crossed and clamped. This will control hemorrhage. The next step is to split the kidney in the plane described by Zondek. (Page 184.) It is usually unnecessary to continue the incision into the upper and lower poles. The plane of the incision should be directed toward the pelvis of the kidney. As soon as one of the calices is opened, the further division may be made upon a curved director or with a pair of blunt-pointed scissors.

If the surgeon proceeds in this manner, he is not likely to overlook even a small stone, or a small abscess cavity, and he does not have to trust to acupuncture, which is a most unreliable method of examination, and one which is not without risk, as shown by a case mentioned by Denecke in which it was necessary to extirpate the kidney on account of hemorrhage following acupuncture.

A careful examination of the ureter ought never to be omitted, and especially so when no calculus is found in the divided kidney. A probe should be passed into the ureter, and should either prove its lumen to be free, or should locate the obstruction and show whether it is due to stricture or kinking, to a valve, to a tumor, or to a stone. Treatment proper to relieve whatever obstruction exists should be forthwith carried out. As the removal of a calculus from the ureter will often necessitate a prolongation of the wound, it is advisable to employ the oblique lumbar incision at first, the lower end of which can be readily extended so as to expose the crest of the ureter. This portion of the incision is about the same as that employed for ligation of the common iliac artery.

If the calculus is situated in the upper part of the ureter, one may

be able to push it with the fingers into the pelvis of the kidney and thus to remove it. Tuffier succeeded in doing this with a stone which was situated as low down as the point where the ureter crosses the promontory. Sometimes the stone will slip from the fingers and pass into the bladder. If the stone cannot be dissolved, it should be cut down upon and removed, the wound in the ureter being closed by Lembert stitches, and the pelvis of the kidney being drained. If the patient is very stout, or if the stone is situated low down in the ureter, it may be impossible to suture the wound made for its removal. Under such circumstances a catheter should extend from the pelvis of the kidney through the ureter, bladder, and urethra. If the condition of the patient does not warrant an operation long enough to remove the ureteral stone, this can, of course, be left, and the operation terminated with drainage of the kidney. If the pelvis is suppurating, or if the ureter contains pus, or if abscesses are found in the kidney, one should not close the wound by suture any more than in other portions of the body tissues similarly inflamed would be so treated. Under such circumstances the wound should be kept wide open. (For further discussion of this subject the reader is referred to what has been said in reference to renal inflammation, page 290 *et seq.*).

Opinion is divided as to whether one should suture a kidney after it has been incised on account of calculous anuria. Loumeau advocates this; while Albarran invariably used at least a drain, and believes that the kidney assumes its normal functions more quickly if it is kept open by a light gauze packing.

Extirpation of the kidney on account of calculus is seldom performed. As soon as the calculus is removed, the condition of the kidney is likely to improve and the outlook for a permanent cure is proportionately good. There are, however, cases in which owing to extensive destruction of the parenchyma it is useless to preserve the small portion remaining, or in which there are so many abscesses scattered throughout the substance of the kidney that its presence in the body is a positive source of danger. Under such circumstance either a primary or a secondary nephrectomy is a justifiable procedure.

If a stone is situated in the lower portion of the ureter, as shown by ureteral catheterization, or by palpation through the vagina or rectum, it is possible to cut down upon it and remove it either from the vagina, or through an incision parallel to Poupart's ligament, the dissection being carried on retroperitoneally until the ureter is exposed. The objections to this operation are its failure to reveal the condition of the kidney, and the possibility that renal calculi will remain after the single calculus is removed from the ureter. Furthermore, suture of the ureter in such a deep wound is difficult unless the urine can be conducted directly from the pelvis of the kidney to the outer world. If the condition on the affected side is a septic one, ureterotomy without nephrolithotomy must be looked upon as an unsatisfactory and inadvisable method of treatment.

stream, being contaminated with tubercle bacilli, is an important factor in the spread of the disease.

These statements in regard to the development and spread of renal tuberculosis have been abundantly verified by experiments upon animals. Five weeks after artificial inoculation with tubercle bacilli miliary tubercles can be found in the kidneys, especially in the vessels of the glomeruli, while the bacilli are also found in the epithelium of the convoluted tubules. These miliary tubercles are associated with the usual degenerative and regenerative processes. They gradually increase in size, and by their union form larger nodules with caseous centres which later break down and discharge their contents.

FIG. 124.

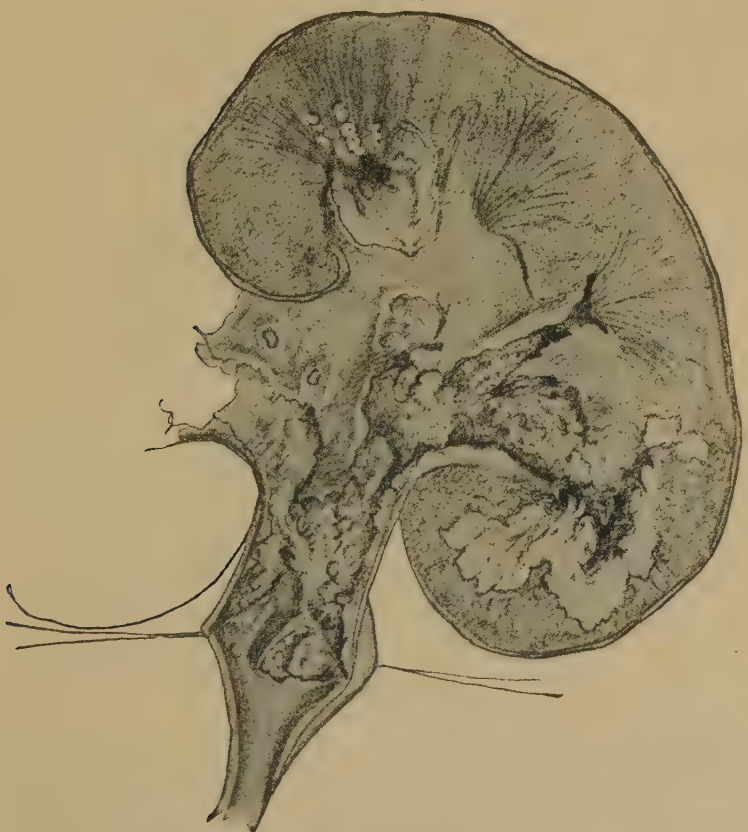
Nodular tuberculous infiltration and cold abscesses of renal parenchyma. Diagrammatic. (Tuffier.)

Thus the development of renal tuberculosis is established clinically, pathologically, and experimentally. Although there are still many minor points which are not clear, the fact that tuberculous infection of the kidney is chiefly due to the escape of tubercle bacilli from a primary infection in some other portion of the body into the bloodvessels has been proved beyond question.

The little grayish nodules which represent the beginning of the disease may develop in small numbers or in great numbers according to the amount of infective material. And they may be confined to a small portion of kidney, or distributed throughout the whole organ, according to the vessel or vessels through which the infecting emboli have come. It frequently happens that only one pole of the kidney is involved. Steinthal's idea that the disease always begins in the base of the pyra-

mid has proved to be incorrect. The first miliary tubercles may be disposed in the form of a cone (Figs. 122 and 123), or they may be isolated in the cortex just above the tunica, or they may follow the vessels and appear in grayish-white stripes from the hilus to the periphery, or they may first appear in the points of the papillæ. Later, miliary tubercles appear in other portions of the kidney, run together, caseate, and form yellowish-gray rounded areas of infiltration which sometimes make elevations on the surface of the organ. (Fig. 124.)

FIG. 125.



Caseous pyelonephritis with ulceration in renal pelvis, calices, and ureter. Primary tuberculosis in a lumbar vertebra.

A rare form of infection is that described by Israel in which numerous foci, varying in size from that of a grain of sand to that of a pea, are disseminated through the whole kidney, but without necrosis and softening. The prognosis of such a condition is most unfavorable. Death comes quickly from the development of tuberculosis in other organs.

In the usual course of the disease the infiltrated areas caseate, break down, and form cavities which unite and ultimately change the kidney into a mere shell with cavities which are filled with detritus and broken-down masses, and whose walls are ulcerated. (Fig. 125.) Such a tubercular abscess soon breaks into the pelvis of the kidney or some one of its calices, and there follows a condition of tuberculous pyelonephritis and ureteritis with diffuse tuberculous inflammation of the mucous membrane of the urinary tract. (Fig. 126.)

The capsule of the kidney meanwhile has undergone fibrous thickening; but in spite of this some tuberculous abscess lying near the surface may break through the capsule, and entering the perinephritic fatty tissue it may lead to the formation of a great perinephritic abscess.

Fig. 126.

Tuberculous pyelonephritis. (Tuffier.)

Great as is the obstruction thus caused, there usually remains a more or less extensive portion of the parenchyma of the kidney which has not been destroyed, and whose function still persists. Therefore when the urine becomes stopped by some of the necrotic masses, as frequently happens, there will be retention of urine and a tuberculous uronephrosis (Fig. 127), which staphylococci and streptococci and bacterium coli will speedily change to a tuberculous pyonephrosis. It is, of course, possible for tuberculosis to develop in a kidney previously uronephrotic. Under such circumstances the change to a tuberculous uronephrosis and tuberculous pyonephrosis takes place even more rapidly, and such is doubtless the origin of some of the tuberculous, suppurating dilated kidneys which are seen.

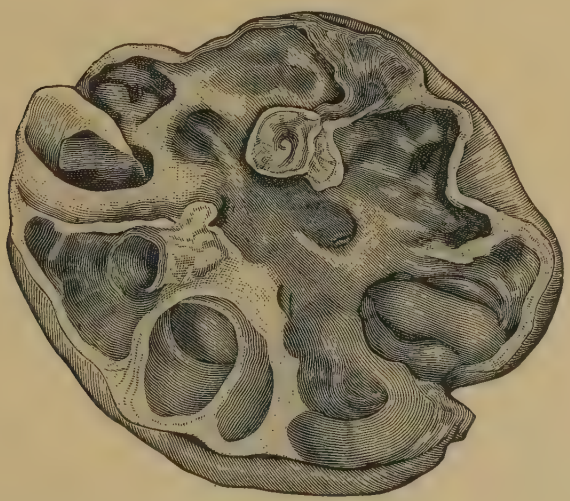
PLATE IX.

Tuberculosis of the Kidney, Associated with a Mixed Infection of Bacillus Coli Communis, showing Advanced Destruction of the Organ. (Wyss.)

It is not, however, necessary that a tuberculous uronephrosis go on to a pyonephrosis. Tuffier describes a case in which the clear, yellowish contents of the sac were free from micro-organisms except for a limited number of tubercle bacilli.

In his excellent monograph upon renal tuberculosis Tuffier describes still another form of tuberculous degeneration of the kidney, to which he gives the name of "dégénerescence massive du rein." This form develops under the same conditions as those of tuberculous uronephrosis—namely, when the ureter is narrow, or is already obliterated. In place of the kidney one will then find a cyst with a thin transparent membranous wall whose contents are uniform, solid, and appear like the thickened contents of a dermoid cyst, or like soluble glass.

FIG. 127.



Tuberculous uronephrosis following tuberculosis of the ureter. (Tuffier.)

Tuberculosis may develop in the kidney in still other ways: thus, Veselin has seen the epithelium of the renal pelvis undergo a transformation into what looked like epidermis with increase in layers of cells, and flattening and cornification of the superficial layers, which were cast off in the form of little shining bits like mother-of-pearl, which collected in the renal pelvis, together with necrotic masses, crystals of cholesterin, and pus, and from time to time gave rise to sharp colic as they passed through the ureter. These descriptions suffice to show that the development of tubercles in the kidney may be variable, a fact which accords with our knowledge of tuberculous processes elsewhere in the body. The stage of miliary eruption does not affect the outward form of the kidney. When the various nodules fuse and begin to caseate, there is a considerable increase in the size of the whole kidney, while the surface may remain smooth or become

nodular. If only one pole is affected, the increase in size may be confined to it. If calcification takes place and cicatricial contraction is more active than formation of new tissue, the kidney may regain its normal size or become even smaller than normal. If a perinephritic abscess, or tuberculous uronephrosis or pyonephrosis develops, enormous abscesses and tumors may be the result. The cut section of the cyst varies as much in appearance as does its outer surface, so that it is not always easy to say without microscopical examination whether a suppurating kidney is or is not of tuberculous origin unless somewhere in the parenchyma there is still to be seen grayish tuberculous infiltration. A microscopical examination will quickly determine the nature of the process, since outside of the caseous detritus there is always a layer of tuberculous infiltration with giant cells and a tendency to sclerosis, and outside of this a layer of connective-tissue and round-cell infiltration. Sometimes only a few giant cells are to be found.

If the tuberculosis extends to the ureter, its wall will become infiltrated, the mucous membrane will ulcerate, and the muscular wall become affected. (Fig. 125.) While these destructive processes are going on the outer layers of the urethral wall are growing thicker (periureteritis), and thus perforation is prevented, and at the same time numerous adhesions are formed. The ureter is gradually changed into a rigid, much enlarged, tense tube, which has a far greater tendency to contract and become obstructed than it has to dilate. Naturally there will be dilatations just above the strictures. The extension of the tuberculous infection from the mouth of the ureter over the surface of the bladder is described below.

The second method by which tuberculosis may develop in the kidney is by infection ascending from the bladder. A pure primary hæmatogenous vesical tuberculosis is of rare occurrence. Still, according to ideas at present held, genital tuberculosis in the male may lead to a secondary tuberculosis of the bladder, and the infection thus produced may ascend to the ureter and to the kidney. The relation between genital tuberculosis and that of the urinary passages is by no means clear, and it is certain that the two forms of disease do not always occupy the relation of cause and effect. They may exist independently. Thus Israel had 3 patients in whom the testicle and kidney were affected, while the bladder was healthy; and Steinthal found in 3 cases that the prostate was healthy, although there was tuberculosis of the kidney and descending affection of the ureter and the bladder, while in 2 cases of renal tuberculosis the vas deferens and seminal vesicles were tuberculous, and in other cases the testicle was affected. Thus, in the majority of cases the prostate is the organ which suffers first when the tuberculosis extends outside of the urinary passages.

Baumgarten, who has recently studied this subject experimentally, comes to the conclusion that tubercle bacilli never multiply either in the urine or in the seminal fluid; that they have no power of motion; and that they can therefore only follow the stream, and not swim

against it. He found that he could produce tuberculosis of the urethra and bladder by injecting virulent colonies into the urethra of rabbits, but he was never able in this way to cause disease in the ureter or vas deferens or the testicle. Tubercle bacilli injected into the vas deferens developed in the prostate, but never in the testicle. To produce tuberculosis in the testicle he found it necessary to make an injection directly into this organ. He admits the possibility of transmission of the disease through the lymphatics which lie in the walls of the urinary passages, but this method of infection has little practical significance. Moreover, it is uncertain whether the lymph-stream in the ureter flows upward or downward.

In cases, therefore, where there is no evident connection between different foci of tuberculosis in the urogenital tract it is probable that the disease is of hæmatogenous origin in both places, or else that it has spread through the lymph-vessels. Theoretically it is possible for tuberculosis in the vicinity to extend to the urinary organs, but in practice this is rarely seen. So far as known, no one has observed a primary urethral tuberculosis.

In spite of Baumgarten's experiments the idea of an ascending tuberculosis will not be readily given up, although different observers ascribe different degrees of importance to this process. It is difficult to deny this occurrence when one sees an extensive tuberculosis of the ureter and bladder combined with a superficial disease in the renal pelvis, and beginning ulceration of one or two papillæ. There was no such case among those described by Steinthal, but others have described them, and Tuffier goes so far as to claim that every tuberculosis of the second kidney is due to ascending infection, an opinion which has been much opposed by others. Under such circumstances the disease in the second kidney will progress through the same stages as the first, although in reverse order. For a certain length of time the lesions will show the origin of the disease, but later there will be no distinction between the part of the kidney first affected and that secondarily infected, or between the processes which have extended downward and those which have extended upward.

The question of the health or disease of the second kidney is of the greatest importance. If tubercle bacilli coming from the blood can lodge in one kidney, they can naturally lodge just as well in the other; and if tuberculosis ascends from the bladder through one ureter, there appears to be no reason why it should not extend upward through the other. Secondary infection of the second kidney is always to be feared when the disease of the first kidney has extended to the bladder.

Therefore one must always consider the possibility that the renal tuberculosis is bilateral. If one refers to statistics to learn how often such is the case, the answers given vary greatly. If the results of autopsies alone are considered, the percentage of bilateral infection will be high, since it is frequently the development of disease in the second kidney which produces death. Surgeons believe that an early inter-

vention will delay or prevent the disease of the second kidney, and they are interested, therefore, in proving from statistics that such a result is at least probable. Morris found 44 cases of renal tuberculosis among 2610 autopsies. The tuberculosis was of the miliary type in 29 cases, and involved both kidneys in 28 of them. In the 15 cases in which the disease existed in the caseous form both kidneys were involved 8 times, while other organs were tuberculous 14 times. In the records of 567 autopsies made at the Presbyterian Hospital of New York, mention is made of 23 cases of renal tuberculosis, 15 of which were bilateral. Vigneron found that of 250 cases of renal tuberculosis mentioned at autopsy 123 were unilateral. Tuffier, who collected statistics of surgical operations, found that 99 of 205 cases of renal tuberculosis were unilateral. He believes that in an early stage of the disease the trouble will be found to be confined to one kidney in a still higher percentage of cases. Israel found the disease confined to one kidney in 16 of 21 patients operated upon, an opinion which was confirmed at autopsy, or by a cystoscopic examination, or by therapeutic results.

Vigneron found the bladder affected 12 times in 23 cases of operative primary renal tuberculosis which came to autopsy, and Israel saw secondary tuberculosis of the bladder develop in 44 per cent. of his cases.

Tuberculosis of the urinary passages is somewhat more frequently seen in women than in men. Vigneron collected records of 79 operations for renal tuberculosis in women and 36 in men. Other writers have given percentages which are substantially the same. In general, it may be said that two-thirds of the patients operated upon were women, and that three-fourths of the cases of primary renal tuberculosis occur in women.

Symptoms.—A disease which produces such various lesions as have been spoken of, must necessarily give rise to a great variety of subjective as well as objective symptoms. On this account the diagnosis of renal tuberculosis may often be suspected when it cannot be proved to exist. In the beginning it may give rise to no symptoms whatever. Tuberculous foci are not infrequently found at autopsy, although no symptoms referable to the kidney have been noticed.

The earliest symptom is usually a dysuria of a reflex character. The urine is possibly under an increased pressure, and there is some pain, especially at the close of the act. Examination of the urine shows it to be normal, or there may be a slight polyuria. Under such circumstances the disproportion between the subjective symptoms and the normal condition of the urine may excite a suspicion of tuberculosis.

At other times the disease begins with attacks of renal colic which may be so severe that they cannot be distinguished from colic due to the passage of renal calculi. The kidney represented in Figs. 121 and 122 was removed by Schede from a man aged thirty years. When

first seen, this patient was apparently in good health except that he suffered from a suppurating inguinal gland, probably of a tuberculous nature. A year and a half later an intensely painful attack with vesical and rectal tenesmus suddenly developed and as suddenly disappeared. A few weeks later he had ten such attacks in a period of fourteen days, and then for four months he had complete immunity from them. Later they returned, and the right kidney was found to be tender, while the urine contained a little pus and some epithelial cells and a few tubercle bacilli. It was therefore removed.

Similar attacks of colic may be caused by the passage of other sorts of bacteria, for example, bacterium coli. The urine should therefore be tested, since their presence if found will establish the diagnosis. These attacks may be caused without retention of urine in the renal pelvis, and without the passage of visible particles through the ureter. They are due, apparently, to inflammatory congestion. It is also to be noted that tubercle bacilli may be found in the urine before there is any destruction of renal tissue. Apparently they filter through the kidney with the urinary stream.

If the destructive process continues, the urine will usually show characteristic contents. It not infrequently happens that a great quantity of pus and detritus suddenly bursts into the urinary stream which previously was almost clear. This is caused by rupture of the tuberculous cavity into the pelvis of the kidney.

When the disease has progressed thus far, the urine will never again be perfectly clear unless retention takes place and tuberculous uronephritis or pyonephritis develops. However, after a cavity has emptied itself the urine may be fairly clear for a considerable time, and the patient will again be comfortable, finding relief from the symptoms due to rupture of the abscess, if the rupture was painful, which is not always the case. Sometimes pus in great quantities continues to be present in the urine, due to a mixed infection with staphylococci, bacterium coli, or, more rarely, with streptococci. At other times hemorrhage becomes a prominent symptom, and may even be a dangerous one. In certain cases in which early ulceration erodes a vessel at the tip of a papilla severe hemorrhage may be the first symptom noted.

As a rule the kidney is somewhat enlarged and is the seat of a constant uncomfortable feeling which may increase to a positive pain. From this time on, the symptoms complained of may vary greatly. There may be polyuria, with vesical tenesmus, cloudy, acid urine, with flakes of pus, detritus, and tubercle bacilli; or in case secondary suppuration due to mucous infection has occurred there may be a mucous, purulent sediment giving a foul smell and sometimes an alkaline reaction to the urine. The urine may also contain more or less blood and blood-clots. The latter may obstruct the ureter and stop the flow of urine, or they may break in pieces and so pass through the ureter. If the ureter is completely obstructed, the urine from the bladder will again become entirely clear as soon as it comes only from the second kidney.

The symptoms are therefore a combination of pyuria, hæmaturia, polyuria (3000 to 4000 c.c. in twenty-four hours), moderate albuminuria, increased vesical tenesmus (incontinence or retention is a symptom of vesical or prostatic disease), and occasional retention of the urine in one kidney with clear urine from the other. Other symptoms are a gradually increasing renal tumor, fever, especially in the periods when the urine is clear, emaciation, disturbance of digestion, cachexia, more or less pain, and ultimately perinephritic suppuration. The urine is acid, or in case of mixed infection possibly alkaline. It may contain pus-corpuscles and large fatty degenerated round cells, epithelial cells, and red blood-cells, fragments of caseous degeneration, urinary concretions, casts, albumin, tubercle bacilli, and possibly other bacteria. Tubercle bacilli are often found with great difficulty.

The specific gravity of the urine is normal; or if the polyuria is marked, it is somewhat decreased. The total amount of urine excreted and the freezing-point of the urine are normal until the progress of the disease in the first kidney, or its extension to the second, or complicating nephritis, or amyloid degeneration affects unfavorably the renal excretion.

If the urine is allowed to stand in a glass, it assumes in a typical case a striking appearance. At the bottom of the glass is a layer of grumous matter streaked with blood, while the upper portion of the urine is more or less opaque. Lebert and Vogel say that fragments of detritus about as large as a pin's head are pathognomonic of tuberculosis.

The results of cystoscopic examination are most striking in certain cases. This is especially true if the disease is confined to one kidney. The mucous membrane at the mouth of the affected ureter is injected. In the region of the trigonum there are a number of sharply outlined, inflamed red spots which are plainly seen in contrast with the otherwise unchanged mucous membrane. This appearance of the trigonum is not, however, confined to renal tuberculosis. It is worth emphasizing that renal tuberculosis may produce vesical symptoms. Symptoms of vesical irritation with increased and painful tenesmus, etc., may exist for a long time, possibly for years, before any anatomical change can be observed in the bladder, such as injection of the mucous membrane or catarrh. Indeed, this vesical irritation may for a long time be the only symptom of beginning renal tuberculosis. It is very noticeable that irrigation of the bladder with a solution of nitrate of silver and similar measures which prove of benefit in case of an ordinary cystitis only increase the symptoms of vesical irritation due to tuberculosis. Therefore, whenever one finds an obstinate vesical irritation without apparent cause, he ought to keep in mind the possibility of renal tuberculosis.

In other cases the mucous membrane of the bladder may be irritated by the urine which passes over it even though this mucous membrane is not the seat of tuberculosis. As the tuberculous disease in the kidney progresses and pyelonephritis and ureteritis are added to it, and

especially if there is secondary infection, the irritation of the bladder caused by the urine becomes much greater. At a later period the bladder may become the seat of tuberculous disease. This usually begins at the mouth of the ureter, where grayish kernels are visible in the mucous membrane, which increase in size, join together, and break down into an ulcer with a grayish base and ragged edges. The bladder becomes less and less tolerant of its contents, so that it will not hold more than 30 to 50 c.c., and its violent contractions produce almost incontinence of urine. Attempts to distend the bladder by irrigation fail. If the patient is anæsthetized, and the bladder is forcibly distended, hemorrhage from the ulcers will result.

These vesical symptoms are naturally the same whether the tuberculous cystitis is primary or whether it is secondary to tuberculosis of the genital organs. In marked cases the firmly contracted bladder may be felt like a solid body, of the size of the uterus, or smaller, close behind the symphysis pubis.

It is worth repeating that long-continued symptoms of vesical irritation, together with the demonstration of tubercle bacilli in the urine, are not of themselves sufficient proof that there is tuberculous disease of the bladder itself. Perthes mentions a case in which a young girl suffered from vesical irritation for eight years, due to tuberculosis of one kidney. There was an ulcer at the neck of the bladder, which was shown by microscopical examination to be non-tuberculous, and removal of the tuberculous kidney relieved the patient of all symptoms.

The importance of a cystoscopic examination is evident. Unfortunately the contracted condition of the bladder frequently makes it impossible to carry this out satisfactorily. If the examination can be made, one will be able to recognize whether pyuria or hæmaturia is unilateral or bilateral or there is a general tuberculosis of the bladder or whether the disease is only commencing at one ureteral mouth, or whether there is simply irritation of the trigonum due to the presence of an abnormal urine.

If tubercle bacilli are present in the urine, it is important to know whether they come from the bladder or from one or both kidneys. The separated urine can be obtained in the case of women by Rose's instrument, and in case of both men and women by Morris's instrument. Unfortunately when urine is obtained by the latter method one cannot say whether tubercle bacilli in it come from the bladder or from the kidney. Catheterization of the ureter is inadvisable on account of the risk of infection. The failure to find tubercle bacilli is no proof that renal tuberculosis does not exist The bacilli may be located in colonies which are still shut off from the urinary passages, or there may be a temporary or permanent obstruction to the ureter.

Diagnosis.—In a few cases injection of tuberculin gives valuable diagnostic indications, such as an increase in the number of tubercle

bacilli in the urine, swelling and greater tenderness of the affected kidney, increased renal hemorrhage, and possibly swelling of the mucous membrane to the point of obstructing the ureter, and the temporary disappearance of cloudiness from the urine in the bladder.

In making a differential diagnosis, it is well to remember that hemorrhage, pain, and enlargement of the kidney are caused by a calculus, or a new growth, as well as by tuberculosis, and that the pain and enlargement may be due to kinking of the ureter, and congestion to the influence of bacteria, and that pain, enlargement, and pyuria are caused by non-tubercular suppuration of the kidney, and that vesical symptoms and tubercle bacilli in the urine may be due to tuberculosis of the bladder. Therefore, hemorrhage, pain, and renal enlargement are not characteristic; and even if the presence of a calculus is definitely shown by the *x*-ray, it may have developed secondarily to tuberculosis, or tuberculosis may follow the formation of the calculus. The local reaction following an injection of tuberculin is a characteristic sign which does not appear under other circumstances, and a general reaction after the injection is an almost certain proof of the presence of a tuberculous foci somewhere in the body. In the present state of our knowledge of the treatment of renal diseases such a fine differential diagnosis is generally not important If it can be shown that there is present either suppuration or calculus in the kidney, or renal tuberculosis, or a neoplasm, the duty of the surgeon is to expose the kidney, and, if necessary, to split it open in order to determine the nature of the disease, and to apply such measures as are indicated.

Treatment.—The treatment of renal tuberculosis is partly medicinal, partly surgical, and it is usually not until medicinal measures fail that the surgeon is called upon for the radical removal of the foci of disease, or to perform such other operation as shall facilitate recovery. It is admitted by surgeons as well as by physicians that renal tuberculosis in its early stages may be entirely recovered from by hygienic medicinal treatment. Most surgeons, therefore, do not advise operation in the earliest stage of the disease. Wandel claims that renal tuberculosis may be recovered from as long as there is no secondary affection, and says that surgical treatment is not indicated until pyelitis or pyelonephritis has developed. Vigneron also speaks of a cavernous or caseous kidney as the "true surgical kidney." But such opinions are not shared by all surgeons. Indeed, many of those most experienced in renal surgery claim that an early radical removal of the diseased part is the treatment best calculated to preserve the other kidney from becoming affected.

It has been shown above that the stage of miliary tuberculosis is often one without symptoms, and that in this period the trouble is not recognized, and cannot well be treated surgically.

Doubtless there are mild cases in which the symptoms are so slight that one can afford to wait. There may be a slight heavy feeling in

the region of the kidney, and a mild vesical irritation, with red spots in the mucous membrane about the mouth of the ureter, and perhaps a few tubercle bacilli in the urine, while the only general symptoms complained of are weakness and disinclination to exercise, and a feeling of pain in the region of the kidney following quick or long-continued motion. Under such circumstances the urine may remain acid and of a normal color. Such a patient may entirely recover his health.

The patient in whom tuberculosis of the kidney is suspected should be kept under close observation. If the medicinal and hygienic treatment is followed by a gradual diminution of the vesical irritation, and the pains in the loin, while the vesical mucous membrane appears improved, and the tubercle bacilli disappear from the urine, which in turn remains acid and becomes constantly clearer, and if the general condition of the patient improves, and his strength increases, operation may be indefinitely postponed. The interpretation of such a sequence of events is obviously that a miliary infection existed which the patient has been able to overcome. On the other hand, if the symptoms increase in spite of the best treatment, operation should be performed without delay. A counterindication for operation is the appearance of multiple foci of tuberculosis or an especially severe localization of the disease in some other portion of the body.

The use of creosote and its derivatives, guaiacol, triocol, etc., in large doses has been well spoken of by several writers. Ichthyol in gradually increasing doses of from 10 to 70 drops, taken in a large quantity of water after each meal, has also been advocated. It lessens the pain and vesical tenesmus, increases the appetite, and improves the nutrition. Some patients have been much benefited by tuberculin.

Guyon says that local treatment by irrigation with nitrate of silver, iodoform emulsion, naphthol, creosote, or lactic acid is wholly useless. He has seen good results follow irrigation with a 1 : 5000 solution of mercuric chloride, which may be gradually increased until it has a strength of 1 : 1000. He injects at first 20 to 30 drops into the empty bladder, and gradually increases this up to 4 c.c. (℥j).

Even in the early stages of renal tuberculosis surgical intervention is sometimes demanded. For example, if there is alarming hemorrhage, or if there are severe attacks of colic, hemorrhage may be the first symptom noticed. Under such circumstances the extent of the disease may be very limited. Albarran opened a kidney after hemorrhage and found in its lower pole a cavity as large as a pea. Loumeau removed a kidney after hemorrhage and found four tubercles each as large as the head of a pin. Other surgeons have reported similar instances. This is not always the case, and even where hemorrhage is the first symptom there may be numerous other miliary tubercles in addition to the one which has given rise to the hemorrhage. A painful miliary eruption has only occasionally been observed, yet the pain may be so intense as to lead the surgeon to remove the kidney.

While a patient in the early stages of tuberculosis may safely be treated medicinally and hygienically as long as the symptoms are mild or are improving, as soon as the symptoms begin to grow worse, or hemorrhage or attacks of pain occur whose cause cannot otherwise be explained, operation should forthwith be considered. If the disease of the kidney is well advanced, the organ should be extirpated if there is reason to believe that all the diseased tissue will thus be removed and if the other kidney is known to be sound. The methods for determining this fact have been spoken of in the preceding pages.

As it is unsafe to catheterize the ureters of a patient who is suffering from renal tuberculosis, one of the best means for determining the health of the other kidney is not available. The various methods for separating the urine have not been tested sufficiently to enable one to rely upon them absolutely, with the exception of Rose's method, which is only applicable to women. Obalinski holds the view that a marked increase in the size of the diseased kidney indicates that the other one is healthy, but such a conclusion is untrustworthy. The diseased kidney may be the only one, and its enlargement may be thus explained.

Therefore, in doubtful cases it is necessary to perform a nephrotomy rather than a nephrectomy. The condition of the patient is often improved thereby, the pains are relieved and retention avoided, as the wound affords free escape to the urine and the pus. Furthermore, it affords the operator an exact knowledge of the degree of destruction which has gone on, and the extent to which the disease has spread. If it is found that the ureter has been completely obstructed without affecting the general condition, or if the parenchyma of the kidney is entirely destroyed, extirpation may at once be performed. If the tubercular foci are limited—for example, if they are confined to the upper or lower pole—partial resection of the organ may be performed.

Albarran mentions a case in which he scraped out the diseased tissue with temporary improvement. The child died, and the kidney operated upon was found to have healed perfectly and to show no evidence of tuberculous disease, death being due to tuberculosis of the second kidney. Unfortunately, the distribution of the disease is such that partial resection will be applicable in only a small number of cases.

If immediate extirpation of the kidney is indicated either because there remains a considerable portion of normal parenchyma and the surgeon has no knowledge of the condition of the second kidney, or if the general condition of the patient is unfavorable to nephrectomy, the surgeon must content himself with a nephrotomy. This operation under the circumstances is a temporary measure to be followed by removal of the kidney as soon as conditions warrant.

There are in literature records of a few cases in which incision of the kidney has cured tuberculous pyonephrosis, the diagnosis having been established by microscopical examination of excised portions of tissue. Such a result is difficult to explain, and it does not affect the

general rule that a nephrotomy under such circumstances is followed by a permanent fistula, and leads to local infection of the perinephritic tissue, while it fails to stop the progress of the disease in the kidney itself.

If nephrotomy is to be substituted for nephrectomy on account of lack of knowledge of a second kidney, the next duty of the surgeon is to determine the condition and functional capacity of this organ. Pinner's method is best adapted to this purpose. It is theoretically possible that the secretion from a diseased ureter mixing with the urine in the bladder should mislead one in forming an opinion of the condition of the other kidney, but practically this may be neglected. If the second kidney is excreting a normal amount of urine, the mixture with it of an occasional pus-cell or tubercle bacillus will not serve as a counterindication for nephrectomy unless one takes the view of Guyon, Vigneron, and others, that any disease, even the slightest, of the second kidney, is a counterindication for a nephrectomy. This view seems to the writer irrational, as does that of other authors who look upon tuberculosis of the bladder as an absolute counterindication to nephrectomy. The question to be determined with reference to the second kidney is its excretory capacity. If it is capable of performing its function satisfactorily, the patient will be far better off if the first kidney is removed, than he will be if this is left in place as a constant drain upon the fluids of the body and a possible source of new infection. If it is true that the early stages of renal tuberculosis may be recovered from under proper medicinal and hygienic treatment, is not such treatment much more likely to succeed in the case of the second kidney if the first one is removed?

In reference to tuberculosis of the bladder, Israel says that this cannot be considered an absolute counterindication for extirpation of the diseased kidney. Removal of such a kidney has been found to be followed by diminution of vesical symptoms even when the bladder is itself tuberculous. Furthermore, it has been shown that vesical symptoms, together with the presence of tubercle bacilli in the urine, do not prove that the bladder is diseased, even though these symptoms have lasted for a long time. Even if the tuberculosis has extended to the bladder and is limited to the vicinity of the mouth of the ureter, the diseased portion may be excised with benefit. Indeed, the whole bladder has been removed, together with one kidney, with success. Finally, there are facts which go to show that the tuberculin treatment may exert a favorable influence upon tuberculosis of the bladder, which cannot therefore be classed with absolutely fatal diseases.

In conclusion, it may be said that neither the probability of the beginning disease in the other kidney nor the existence of tuberculosis in the bladder is sufficient reason in itself to prevent extirpation of the tuberculous kidney, provided the extirpation is desirable on other grounds and the second kidney is known to be functionally capable. Under such circumstances the general condition of the patient and any

other local manifestations of tuberculosis are worthy of the most careful consideration.

In renal tuberculosis nephrotomy is either a preliminary or a palliative operation. In the latter case it is intended to lessen the suffering of the patient and to postpone somewhat the inevitable termination.

If nephrotomy is merely a preliminary operation, nephrectomy should follow it as soon as possible. If the nephrotomy is performed simply because knowledge of the functional capacity of the second kidney is wanting, the nephrectomy need not be delayed more than one or two weeks; and if nephrotomy is performed because the patient does not seem able to endure a nephrectomy, the major operation ought not to be delayed more than six or eight weeks, for within this time whatever benefit follows the free escape of urine and pus will be gained, and there is no advantage in postponing the nephrectomy for a longer period.

When the kidney is removed for tuberculosis the fatty capsule should be removed with it. This makes it more likely that all the diseased tissue will be gotten rid of. Sometimes, however, the adhesions are so extensive that it is impossible to carry out this operation in the manner desired. Sometimes it is with great difficulty that one removes even the whole of the kidney. Under such circumstances the organ may be removed piecemeal—renal morcellement, as this operation is called.

The best treatment of a tuberculous ureter is to remove it entire down to its entrance into the bladder whenever it is palpably thickened, or its mouth has been shown by the cystoscope to be diseased. This is the treatment which is at present advocated by the surgeons who are recognized as the leaders in this field. Previously, the treatment was to extirpate as much as possible of the ureter, to cauterize the stump, and to suture it in the wound.

While removal of the whole ureter is desirable, it adds considerable risk to an operation which is already severe, and the prolonging of the narcosis may have a serious effect upon the remaining kidney. There is also reason to suppose that tuberculosis of the ureter may disappear spontaneously when the infected kidney has been removed. Therefore, Schede extirpates the ureter as far as this can conveniently be done, and sutures its stump in the lower angle of the wound after curetting away the mucous membrane and burning the lumen with the Paquelin cautery. The ureteral stump is later treated with injections of iodoform, lactic acid, etc. He treated 22 cases in this manner after extirpation of a tuberculous kidney, and of the 16 patients who recovered not one was troubled with a permanent fistula.

If the ureter shows no tendency to heal and the vesical ulceration around its mouth persists, it should be removed, together with a portion of the bladder, by a subsequent operation. It is still too early to decide whether in case the bladder is extensively diseased it should be removed and the other ureter implanted in the intestine.

Results of Operation.—The results of renal extirpation for tuberculosis are by no means unfavorable, and, as might be expected, more recent results show an improvement upon the earlier statistics.

Schmieden collected records of 201 nephrectomies for tuberculosis, and gives the mortality of lumbar nephrectomy as 27 per cent., and that of abdominal nephrectomy as 42 per cent. He makes the mortality of primary nephrectomy slightly less than that of secondary nephrectomy.

The results of individual operators are naturally somewhat better. Thus Israel reports 29 nephrectomies for tuberculosis, 1 resection of the kidney, and 2 nephrotomies. The bladder was infected in 14 cases, and 11 of these patients were cured, while 3 died from disease of the second kidney or from miliary tuberculosis of the lungs. At the time of report recoveries had lasted from eleven months to nine years in 6 cases. One of the 8 patients whose bladders were also affected died from the operation, while 3 of those who survived operation were apparently cured of the vesical tuberculosis. In 3 patients the disease undoubtedly extended from the bladder to the kidney. They all died after nephrectomy. In 3 cases the origin of the tuberculosis was not clear. Three of these patients recovered and one died.

Tuffier gives his operative mortality after operation as 12.5 per cent., Küster gives his as 10.5, Albarran as 12.5, and König as 33 per cent.

The writer has reported 22 nephrectomies for tuberculosis, some of them as long ago as 1886, with 16 recoveries. Three patients died from the operation on account of insufficient capacity or absence of the second kidney; 3 others died in the course of the year after operation, from extension of the disease to the other kidney or to other organs. This gives an operative mortality of 13.6 per cent. Of the patients who survived, 10 were in good health for two years or more. Thus a permanent cure was obtained in nearly one-half of the cases.

Kümmell made use of cryoscopy to determine the functional capacity of the other kidney before performing nephrectomy for tuberculosis. He lost only 1 patient out of 15 operated upon, and that one died from pulmonary tuberculosis, the other kidney being sound. It is fair to assume that the outcome of surgical operations on the kidney with the means for exact diagnosis now available will be far better in the future than it has been up to the present time.

PERINEPHRITIS.

Inflammation and abscess formation in the fatty tissue surrounding the kidney are known as perinephritis. This was first described by Rayer in 1889, although it was known before this that suppuration within the kidney due to calculus could break through the kidney and extend into the tissues. Different names have been given to such

inflammation of the fatty capsule and its vicinity, such as perinephritic abscess or paranephritis.

Etiology.—Inflammation of the perinephritic tissue may be due to extension from a neighboring tissue. Thus, an inflammatory affection of the kidney, or of the stomach or intestine, or of the liver or gall-bladder, or of the psoas muscle or vertebral column may lead to suppuration of the fatty capsule. Any abdominal affection which can produce directly or indirectly suppuration in the retroperitoneal tissue can cause perinephritis. Among such affections may be mentioned perimetritis and appendicitis, and inflammation of the ovaries, as well as diseases of the bladder, testicles, vas deferens, or of the lower extremities. Empyema may break through the diaphragm and thus cause suppuration around the kidney. Such extension is favored by the weak development of the diaphragm immediately above the kidney, so that, as Tuffier has remarked, the pleura is often directly connected with the perirenal fat. Inflammation may extend to a considerable distance, especially if it reaches one of the connective-tissue spaces whose loose meshes offer little resistance to its progress.

It is not quite so easy to understand why a perinephritis should follow acute infectious diseases, such as smallpox, typhoid fever, scarlet fever, puerperal fever, diphtheria, etc., as well as boils, abscesses, and infected wounds, or, indeed, such slight accidents as muscular strains or blows upon the loin. Recent investigations have thrown much light upon this subject. The kidney is now known to be one of the chief means the body has of getting rid of bacteria; furthermore, the bacteria of the intestinal tract are now known to play an important part in the development of inflammatory processes of one sort or another; while, finally, anatomists have pointed out ways for the spread of inflammation which were previously unknown.

As previously stated, the fatty capsule is surrounded by a layer of fascia called the "fascia renalis" by Gerota, and by which it is separated from the true retroperitoneal tissue. This fascia is open below in the region of the lower pole of the kidney, and here the tissue of the fatty capsule is continuous with the retroperitoneal fat. The idea previously entertained that the fat about the kidney was only a part of the retroperitoneal fatty tissue is therefore erroneous.

Lejars and Tuffier have studied the vessels of the fatty capsule and found that the largest veins of the perirenal zone enter directly into the branches of the renal vein at the hilus, while those of the upper pole connect with the suprarenal vein and those of the lower pole with the venous plexus of the ureter. There are abundant anastomoses between the veins of the fatty capsule and the veins of the renal parenchyma. There are also anastomoses with the veins of the plexus spermaticus.

Stahr, who has carefully studied the relations of the lymph-vessels of the kidney and the fatty capsule, published a report in 1899 in which he showed that the kidney is not poorly supplied with lymph-

vessels as was previously supposed. On the contrary, it possesses a rich network of lymph-capillaries, while a second network lies in the deeper layers of the fibrous capsule, and a third and very extensive network lies superficially in the fatty capsule. These connect freely with one another and with the lymph-capillaries of the cortex of the kidney.

The lymph-glands with which the kidney is connected belong to a large group of twenty to thirty lumbar glands situated on both sides of the lumbar vertebræ, close to the aorta and vena cava. The lymph-vessels of the kidney are especially connected with the upper glands of this system. Small glands are often found between the renal vein and the vena cava. The lymph-vessels of the kidney emerge at the hilus, while the lymph-capillaries from the fatty capsule are connected directly with the lymphatic glands.

Thus the bloodvessels and lymph-vessels of the fatty capsule are intimately connected with those of the kidney itself, and it is easy to understand that an inflammatory process near the kidney may extend by contiguity to the fatty capsule without any gross evidence of the way it has travelled; and it is also possible that infection of the fatty capsule may develop without a previous inflammation of the kidney, even though the infection comes from this organ.

It has been clinically established that the urine of a scarlet fever patient may carry the contagion. This is also true of recurrent fever, typhoid, and malaria. Experiments have shown that within four hours, more or less, after injections containing various bacteria, the organisms may be found in the urinary passages. This fact has been demonstrated in the case of many kinds of pathogenic bacteria. More recently the bacteria which produce catarrh of the bladder, pyelonephritis, and renal abscesses have been carefully studied by a large number of investigators who, almost without exception, agree upon the important rôle played by bacterium coli in these infectious processes. Other important bacteria are: staphylococcus pyogenes, proteus, streptococcus, gonococcus, typhus bacillus, diplococcus of Friedländer, pyocyaneus, bacillus tetragenus.

It must therefore be concluded that all the bacteria which are usually associated with suppurative processes may at one time or another be found not only in the severe forms of renal suppuration, but also in the simpler catarrhal affections of the mucous membrane of the renal pelvis. The second point which has been established is even more important, namely, that pathogenic bacteria capable of causing inflammation, which enter the blood-stream from whatever source, may pass through the kidneys without making their presence known by any changes in the urine. There are, therefore, plenty of opportunities for bacteria and suppuration to come into the immediate neighborhood of the perinephritic tissue. It is evident that bacteria which can pass through the capillaries into the urinary tubules may also pass through the capillaries into the fatty capsule.

It is not necessary that every perinephritis should be suppurative any more than that every inflammation in other portions of the body should be suppurative. Indeed, under certain circumstances the tendency is rather toward a more chronic form of perinephritis which terminates in a cicatricial thickening and contraction. Such processes are well known as accompanying renal tuberculosis, renal calculus, renal abscesses, etc. The result may be intense attacks of renal colic with increased tension of the fibrous capsule due to renal congestion as the cause of renal colic. It is easy to understand that a fibrous degeneration of the fatty capsule may bring about similar symptoms. However, such a non-suppurative perinephritis is pretty generally overlooked, and usually the term "perinephritis" refers to the suppurative form of inflammation, or to a perinephritic abscess.

A perinephritic abscess may be the immediate result of suppuration of the kidney with rupture of the pus through the fibrous capsule. Such an abscess may assume great size, and its origin as coming from a renal calculus was understood by the ancients. However, it need not necessarily come from a calculus, since a simple abscess in the kidney, or one associated with tuberculosis, may break and extend outward in the manner described. In many cases rupture of such an abscess is preceded by fibrous change and thickening of the fatty capsule, so that the abscess will be walled about even after it ruptures into the fatty capsule. In this manner extension of the abscess to the loose retroperitoneal tissue may be prevented. But the usual course is that the affected capsule rapidly breaks down while the suppuration extends around the kidney. If the pus is not given an external vent by the surgeon, it will collect in greater and greater quantities until it extends from the diaphragm to the brim of the pelvis, or possibly into the pelvis, pushing the peritoneum before it toward the median line.

It has already been intimated that the cause of the perinephritic suppuration is not always to be made out. There are many cases of this sort in which there is absolutely no evidence of renal disease, the urine being constantly normal, while incision of the huge abscess is rapidly followed by a complete recovery. Such cases show clearly that perinephritic inflammatory processes may be quite independent of renal disease.

If a perinephritic abscess follows a traumatism, such as a blow in the loin or severe muscular exertion, there will be found in its cavity a mixture of urine, blood, and pus, together with very offensive gangrenous fragments of the injured kidney. If the injury to the kidney is slight, perhaps a single rent, it may repair itself. But even then some blood, or some blood and urine, will have escaped into the contused perinephritic tissue and have been absorbed. If such blood, or blood and urine, contains pathogenic organisms, they will find a suitable soil for their development. If the injury affected the ascending colon and bacteria coli escaped through the intestinal wall, the resulting abscess will have a strong fecal odor. In this manner are to be ex-

plained the so-called metastatic perinephritic abscesses which occur in infectious diseases, as well as those which occur after simple boils and other local suppurative processes. Since we know that the bacterial cause of such troubles, namely, the staphylococci, may be eliminated through the kidneys, the occurrence of perinephritic abscesses under such circumstances is no longer a puzzle. The development of abscesses following upon obstinate constipation is explained by the fact that under such circumstances bacteria coli may penetrate the intestinal wall. The development of a perinephritic abscess following exposure to cold and wet may be explained on the same principles as the occurrence of osteomyelitis under similar circumstances. Simple local disturbances of the circulation can drive into the perinephritic tissue bacteria which are on their way through the kidney. It is also not difficult to see how gonococci or other bacterial agents of a pyelitis may find their way into the perinephritic tissue without setting up suppuration of the kidney.

It will thus be seen that the investigations of recent years have shown that the so-called idiopathic perinephritic abscesses have really the same simple and direct origin as other abscesses. It is true that the bacteria existing in the pus of a perinephritic abscess have been isolated in comparatively few cases, the tubercle bacillus being the one whose presence has most often been reported. But other kinds of bacteria have been isolated, such as the pneumococcus, staphylococcus, streptococcus, bacterium coli, etc.

Symptoms.—A perinephritic abscess may extend in various directions, but fortunately its most common rupture is outward. The thinness of the abdominal wall in the lumbar region affords little resistance to the purulent infiltration and continual pressure of a suppuration. The skin becomes œdematous, then red, and finally the pus bursts through. Such spontaneous rupture is apt to take place either just above the crest of the ilium or just below the twelfth rib. It can, however, break further forward, or higher or lower than the points indicated. It may even discharge into the spleen and liver; or burst forward into the free abdominal cavity, or into the duodenum, or ascending or descending colon. It may also work downward and empty into the bladder or vagina.

The course of the trouble is variously modified according to the virulence of the bacteria present and according to the origin of the process. If the abscess has broken through from the kidney into the fatty capsule, urine is mixed with the pus, and there may follow a gangrenous destruction of the fatty tissue and an intense septic condition of the patient, just as may occur in any urinary infiltration. In two instances necrosis of the whole kidney has been observed.

On account of these variations in the cause and progress of the disease the clinical picture varies greatly within certain limits. There will also be the signs of deeply seated diffuse suppuration, but the symptoms may come on suddenly and with great intensity, with marked

chills and high fever; or, they may develop gradually and be of a milder character. As the disease progresses fever will almost always be present, and will usually be high. Sometimes, if the general condition is not much disturbed, the rise of temperature will be insignificant. The course of the fever differs in different cases, and is in no wise characteristic.

Sometimes there is more or less tenderness in the lumbar region. This is marked by its deep situation and its constant presence. As it is made worse by every sort of pressure, the patients avoid everything which will raise the pressure within the abdomen; for example, deep respiration, straining, coughing, etc. On account of the natural tendency of the process to break posteriorly, pressure on this side of the kidney usually excites the most pain.

If the original site of the perinephritis is in the region of the upper pole of the kidney, pleuritic and pneumonic symptoms will develop early. There may also be vomiting, hiccough, and icterus. Contractions of the psoas muscle, radiating pains to the thigh, paræsthesia in the scrotum and vulva, and œdema of the leg on the affected side, are symptoms which accompany a large abscess of the lower pole. If the pus is situated in front of the kidney, there may be transudation into the peritoneal cavity, or the suppurative inflammation may extend to the peritoneum, in which case the symptoms of peritonitis will overshadow all others. Other symptoms frequently noted are constipation, due to pressure upon the colon, albuminuria, due either to previous renal disease, or fever, or pressure upon the renal pelvis and ureter.

If the abscess is very large, it may surround the kidney on all sides, and the symptoms present will then be a combination of those given.

Diagnosis.—The diagnosis in the beginning is often difficult. Before the abscess has fully developed it may not be clear whether the patient has an acute exanthema, such as acute typhoid, or pneumonia, or, possibly, merely neuralgia. Furthermore, if the patient has previously suffered from renal disease, the symptoms of the old trouble may return under the influence of the perinephritis and serve still further to obscure the diagnosis. Under such circumstances it is better for the surgeon to wait, limiting his efforts to the use of ice or wet applications. The bowels should be thoroughly emptied.

When the abscess has fully developed, the diagnosis can hardly be mistaken. The space beneath the ribs will be filled out on the affected side, a point which is especially noticed when the patient is in a sitting posture. That the swelling is due to an abscess will be shown by the resistance, by its immobility, by the presence of ballottement, by tenderness on palpation, and, in advanced cases, by œdema of the overlying sound parts and the feeling of a soft spot at the point where the abscess most nearly approaches the surface; or, finally, by fluctuation. If doubt still exists, it can be removed by the insertion of an aspirat-

ing-needle. The needle should, of course, be introduced from behind in the line of Simon's lumbar incision.

If the patient is seen for the first time when the abscess is already very large, it may be impossible to determine its origin. The abscess may have extended from below upward, or from below downward, and it may have come from an empyema or an appendicitis. Even after the incision has been made the origin of the trouble may still be obscure.

Treatment.—The abscess should be opened widely. The best incision for this purpose is Simon's lumbar incision. If the conditions found demand nephrotomy or nephrectomy, this incision may not suffice. Therefore, Küster advocates the opening of a perinephritic abscess by means of a transverse or oblique lumbar incision in order to proceed if necessary without delay to more radical treatment. If the timely opening of the abscess is postponed, the patient is subjected to the risk of perforation into other organs, such as the intestine, the lung, the pleural or peritoneal cavity, vagina, the pelvis of the kidney, or the bladder. Rosenberger collected reports of 26 cases of such perforation, in 15 of which the perforation terminated fatally. Küster collected 230 cases of perinephritis, with 34 ruptures into other organs, equal to 14.8 per cent. The rupture was into the pleura and lungs in one-half the cases, and into the intestine in most of the remainder.

Prognosis.—The figures of mortality have little value in the case of a trouble whose origin is so variable as that of perinephritis. Küster believed the total mortality to be 34.3 per cent. It is, of course, useless to combine cases of simple idiopathic suppuration of the fatty capsule with those in which a suppurating kidney has burst outward. If the cases are divided into those which are simple and those which are complicated, the figures show 16.8 per cent. of mortality in the former class, and 49 per cent. of mortality in the latter; while the mortality in those secondary to suppuration of the kidney is 53.5 per cent., the deaths being almost invariably due to destruction of the kidney.

But even in the first group of uncomplicated cases there are reported many deaths which might have been avoided if the surgeon had possessed a better understanding of the subject, or had been able earlier to evacuate the pus. The surgery of the kidney no longer stands at the point at which it stood when many of these deaths occurred; thus there were 17 deaths reported from pyæmia and septic processes. Such deaths to-day are almost always avoided. More recent statistics show that in the vast majority of cases the danger to the patient is not from the perinephritis, but from the condition which precedes it, or from accidental complications; for example, bilateral affection of the kidneys, renal tuberculosis, pneumonia, metastasis in the lungs from suppurative thrombi, etc. Thus, perinephritis of itself is not a very serious disease, the prognosis in any given case being dependent upon the cause of the perinephritis.

On the whole, perinephritis is relatively rare. Socin found 4 patients affected with it in a total of 16,661, while Sutter found 1 patient affected with it in a total of 4437.

ESSENTIAL RENAL HEMORRHAGE.

In the preceding pages it has been stated that hemorrhage from the kidney is a symptom which may result from a number of diseased conditions. Thus it may be due to trauma, to calculus, to tuberculosis, or to new growths. And it may also result from simple retention of urine, as shown by experiments upon animals, and by the hemorrhage which is often observed in cases of uronephrosis. Such hemorrhage is presumably due to secondary congestion. In the case of hemorrhage which occurs in connection with prostatic disease, infection, nephritic trouble, and perhaps sudden evacuation of urine from passages which have been overdistended, unite to cause the bleeding.

In tropical countries bloody urine may be due to various parasites, such as distomum hæmatobium, filaria sanguinis, strongylus gigas, and nephrophages sanguinarius. The first-named two parasites produce at the same time chyluria, and those last named fibrinuria. The urine in chyluria on standing separates into three layers, of which the lowest contains blood, the middle more or less clear urine, and the uppermost the fatty emulsion. These symptoms disappear as soon as the patient is transferred to a temperate climate, so that they are rarely observed except in the tropics.

Hemorrhage may also occur as a complication of inflammations of the kidney, but such hemorrhage is for the most part insignificant, and often only to be made out by means of the microscope. Indeed, it is only recently that it has been recognized that renal hemorrhage in a greater than microscopical quantity can be due to parenchymatous or interstitial inflammation.

Sabatier in 1889 called attention to a series of symptoms not previously described. A patient aged thirty, otherwise well, suffered periodically from extremely painful attacks in the right lumbar region, the pain extending downward to the ureter and bladder and upward to the diaphragm and right shoulder. Hæmaturia accompanied the attack and lasted somewhat beyond it. The region of the kidney was tender, but the organ could not be felt. Sabatier opened the kidney expecting to find a stone. None was found, but the wound in the kidney bled so freely that the organ was removed. It was examined microscopically and showed nothing except a moderate degree of interstitial nephritis.

Sabatier also reported a similar experience with a man aged fifty, in whom hemorrhage was almost continuous.

The report of these cases was followed by reports of similar cases by other surgeons, and the subject of renal hemorrhage was widely discussed. Some men took the ground that the kidney under such

circumstances had a special tendency to bleed, hence the name renal hæmophilia. Others advanced the theory that the influence of the nerves upon the renal vessels was weakened, and that therefore congestion and hemorrhage occurred. It is unnecessary to mention all the different theories which were advanced to explain these cases. For an able discussion of the subject the reader is referred to a paper by Malherbe and Legueu which was presented to the French Urological Society in 1899.

The latest knowledge of this subject may be summed up in the following paragraphs:

1. Hemorrhage may occur after severe and long-continued muscular exertion and jarring. It is frequently observed as a result of long-distance horseback rides, or bicycle rides, or mountain-climbing. Such hemorrhage disappears with rest and does not recur unless the cause is repeated. The urine again becomes perfectly normal. There is no recorded pathological examination of a kidney that has bled under such circumstances, but the hemorrhage is doubtless due to overfilling of the organ with blood, and may therefore be looked upon as the combined result of active and passive congestion.

2. Renal hemorrhage occurs in children, and has been compared by Grisolles to the nose-bleed of childhood. Rhachitis and an excess of phosphates in the urine, also an excess of oxalates and uric acid, have been observed in connection with such renal hemorrhage. The sharper crystals have been thought to wound the parenchyma, and so to produce hemorrhage.

3. Hemorrhage from a movable kidney has been observed in a few instances, sometimes accompanied with intense pain. Guyon exposed a kidney which had been bleeding for almost two years, split it open, and found nothing. This kidney was adherent in an abnormal position. It was freed, replaced, and affixed, and the patient recovered without return of the hemorrhage. Such a hemorrhage is thought to be due to a congestion which follows kinking of the ureter or of the renal vessels. If this theory is correct, it is easy to see why fixation of such a kidney will prevent the hemorrhage.

4. Hemorrhage occurs in connection with uronephrosis.

5. Guyon calls attention to the occurrence of renal hemorrhage during pregnancy and lactation. The women so affected were otherwise healthy, and never suffered from hemorrhage except when in the condition mentioned. The cause of the hemorrhage is considered to be simply venous congestion with which there may be moderate inflammation.

6. In a certain number of cases of unilateral renal hemorrhage operation shows the presence of limited areas of cicatricial contraction mixed with areas of parenchymatous inflammation. Sometimes examination of the urine in such cases shows the presence of albumin or blood-casts. When the safety of nephrotomy became known, it was natural to make use of this operation in the treatment of such kidneys,

since when they were extirpated little was found to justify their removal. Sometimes the effects of an old interstitial inflammation are found in both kidneys although hemorrhage comes from only one. The modern palliative treatment of the kidney has demonstrated the fact that there may be an intense hemorrhagic nephritis which affects only one kidney, the only symptom of which for a long time may be the repeated hemorrhages. The disease may prove fatal without affecting the other organ.

7. A traumatism may cause an obstinate, long-continued bleeding even though the injury seems slight and the first hemorrhage is not alarming in size. In such instances the hemorrhage may be kept up by chronic interstitial inflammation of the kidney. In a case mentioned by Nimier only a single papilla was affected, but the bleeding continued until the kidney was removed.

8. There is a true renal hæmophilia, but this diagnosis should not be made unless the patient has given other evidences of hæmophilia. Hemorrhage from a single organ, even if combined with a family history of hæmophilia, is not a sufficient basis for the diagnosis. Grosglik thus describes a typical instance of hæmophilia. A powerful man, aged thirty-six, inherited hæmophilia from both his father's and mother's families. As a child he suffered from profuse epistaxis, and later he had rectal hemorrhage without hemorrhoids, and bled easily from the gums. After the renal hemorrhages began the others ceased. Similar instances have been reported by several other observers.

9. Suter and Venwick mention cases of unilateral hemorrhage due to a telangiectatic condition of the renal pelvis and ureter.

10. Angioneurotic hemorrhage from the kidney is the final form of essential renal hemorrhage mentioned. It will have been observed by the careful reader that an exact examination often reveals the cause of renal hemorrhage even though the latter appears to be spontaneous. Sometimes it is an inflammatory process with sclerosis; sometimes irritation or acute or passive congestion, or some disease of the blood. A careful analysis clears away from these instances of hemorrhage the mystery which surrounds them. But even the most careful investigation fails to reveal an explanation for some cases of renal hemorrhage, which are therefore set down as angioneurotic. It is a well-known fact that the nerves exercise a direct influence upon the quantity of blood in the vessels. Whether it is possible for the nerves so to distend the vessels that they burst and hemorrhage takes place has not been proved. As this is considered probable, it is fair to speak of angioneurotic hemorrhages. Experimental hemorrhages have been produced in the lung, in the mucous membrane of the stomach, and in the suprarenal bodies by various injuries of the brain and spinal cord. The angioneurotic theory is supported clinically by the occurrence of renal hemorrhage associated with more or less pain for which no cause can be discovered. Under certain circumstances kidneys have been

removed and found to be normal, while in a case mentioned by Klemperer a cure followed a purely psychic and medicinal treatment.

In drawing a conclusion from such cases, none ought to be considered except those in which all other causes for the renal hemorrhage have been excluded by the autopsy. Even after the application of this strict rule there remain at least 6 recorded cases which prove that there is an essential renal hemorrhage; that is to say, one which cannot be explained by general infection or toxic influence, and which is not due to any apparent local cause. Such a hemorrhage may properly be looked upon as angioneurotic.

Diagnosis.—Renal hæmophilia when due to displacement of the kidney, or to pregnancy, or when occurring as a part of general hæmophilia, does not usually present a difficult diagnosis. In making a diagnosis of this kind of hemorrhage it is first necessary to determine the source of the blood. A careful cystoscopic examination of the bladder should prove that the blood does not come from the bladder, but pours out of one of the ureters. If a blood-clot remains for some time either in the pelvis of a kidney or in the bladder, a change of the hæmoglobin into hæmatin takes place as the blood-clot slowly degenerates. This will give a leathery color to the red blood-corpuscles and to the other organized portions of the urinary sediment. The spectroscope will show that this is due to hæmatin.

The second point in the diagnosis is the examination of the urinary sediment, and the examination of filtered urine in order to determine the presence of albumin. If albumin is found, even though there have been no colicky pains, the hemorrhage is probably from the kidney. If the patient has been suffering pain, one should think of calculus and a kinking of the ureter. However, it is not possible to exclude commencing tuberculosis or neoplasm, since hemorrhage sometimes occurs without the appearance in the urine of tubercle bacilli or fragments of a new growth.

Angioneurotic hemorrhage is marked by its long continuation, by its uniformity, and by the fact that it is not affected by outside influences. It continues almost the same whether the patient is quiet or moving about; but this is also true of the hemorrhage from some neoplasms.

The volume of the hemorrhage may be so considerable as to constitute a serious danger.

When all points have been considered, the diagnosis of renal hæmophilia can be made with a certain degree of probability. Only nephrotomy can increase this probability to a certainty.

Treatment.—For the most part the treatment has been already indicated. It consists in a quiet life, a milk diet, and the administration of hydrastis, stypticon, ergot, or suprarenal extract. Success has followed the use of such treatment, but it is the exception rather than the rule. It may be necessary to terminate an existing pregnancy or to suture a movable kidney. Sometimes the hemorrhage ceases after the

kidney is exposed, drawn out of the wound, examined and replaced, but such results must be regarded as happy accidents. The diagnosis will remain uncertain and the hemorrhage is likely to recur and demand more serious treatment; for it may be due to tuberculosis or commencing new growth, as has been stated above.

If the internal treatment fails to control the hemorrhage, nephrotomy must be considered. Only by this means can one make an accurate diagnosis of small foci of tuberculosis, of abscesses, of calculi, or of the causes of retention of urine. Furthermore, nephrotomy will frequently cure the patient of active or passive congestion. Pyelotomy is less advisable, although it has been performed with success in the case of dilated renal pelvis. If tuberculosis or a new growth is found, resection or extirpation may be indicated; or if a calculus is present, this should be extracted, or any other indication for treatment carried out. The nephrotomy wound should be drained with gauze.

Nephrotomy has entirely supplanted nephrectomy in the treatment of these cases since it has been learned that the hemorrhage can be controlled, and nothing further is to be gained by the removal of the kidney. The mortality after operation of this character ought not to be large. There were 3 deaths in 14 recorded cases of nephrotomy for hemorrhage. The three patients that died all suffered from bilateral nephritis.

If from the family history and the history of the patient a diagnosis of true renal hæmophilia is made; that is to say, renal hemorrhage in a hæmophiliac, operative procedure should be avoided if possible. If the character of the hemorrhage is such as to make operation imperative, the surgeon may expect to find that nephrotomy will be followed by continued bleeding in spite of gauze packing and sutures, so that nephrectomy may be necessary.

RENAL NEURALGIA.

This affection has been described by French writers more than by others, and most of the cases hitherto included under this heading will not withstand careful analysis in the light of the present knowledge of renal disease. Some cause for the pain is usually evident, although the condition may not be such as was formerly supposed to be necessary to produce pain in the kidney.

It has been shown above that renal pain may be due to a great variety of causes, and that renal colic is no such characteristic symptom of renal calculus as was formerly maintained. Indeed, in a majority of cases the cause of renal colic is something else than renal calculus. A renal calculus for the most part produces only indirect pain unless it finds its way into the ureter. The common causes of pain are inflammatory processes associated with hyperæmia and congestion, and

conditions which produce retention. The pain in all of these cases is due to an abnormal stretching of the fibrous capsule.

Medical literature contains many cases in which pain has led to a diagnosis of renal calculus, while at operation the surgeon has found no stone, but perhaps a movable kidney or a displaced kidney, with kinking of the vessels of the hilus, or the formation of a valve at the entrance to the ureter, with beginning uronephrosis, or a thickened fibrous capsule adherent to the fatty capsule, or cicatricial contraction of the cortex, or sclerotic foci in the parenchyma, or recent bacterial emboli, or intense hyperæmia, or diffuse congestion.

Israel believes that spastic contraction of the ureter, or swelling of its mucous membrane, may cause transitory obstruction to the urinary flow.

Treatment.—In the light of this knowledge as to the manifold etiology of renal colic it is not surprising that the attacks may be relieved by measures other than extirpation. Thus cure may follow nephrotomy, or any other operation which relieves the tension of the capsule, restores urinary flow, and establishes a free circulation of blood. These ends may be attained by nephropexy or a plastic operation upon the ureter, by division of the fibrous capsule, or by freeing the kidney from adhesions. Splitting of the capsule was first practised by Le Dentu in 1881, and in the last few years has been many times carried out with success. It has been mentioned above that renal neuralgia may be associated with hæmaturia. This diagnosis was formerly considered satisfactory, but at the present time one seeks further in order to know the cause of both pain and hemorrhage, whether due to inflammatory conditions, or to arterial or venous hyperæmia, or to retention of urine.

Israel has recently reported 14 cases of splitting of the kidney for acute and chronic disease of the renal parenchyma with pain, and with or without hemorrhage. In two of these cases there were strong adhesions between the fatty capsule and the fibrous capsule. In 9 cases there was undoubted disease of the kidney, shown by occasional or continuous renal elements in the urine, or by direct examination of the kidney. In 3 cases the urine contained abnormal renal elements, but there was no change in the parenchyma which could be detected with the eye. These cases of nephritis differed from those usually seen :

1. By the paroxysmal attacks of pain, which were so severe that they might have been caused by renal calculus or tuberculosis.

2. By the fact that symptoms were unilateral. In some cases both kidneys were found diseased, although the pain had always been confined to one side.

3. By the absence of albumin in the urine even in the case of kidneys proved microscopically to be markedly diseased. This point is valuable as showing that the absence of albuminuria is not sufficient proof that the kidneys are healthy.

While admitting that the passage of blood-clots with the urine may cause pain, Israel holds that this is by no means necessary. During the attack urine which has previously been bloody may become free from blood, so far as the eye can judge, to become again bloody after the attack has passed over. The urine may remain free from blood even though an attack lasts several days, the first trace of blood being seen as the pains pass away. In other cases the urine is free from blood during an attack as well as between attacks.

The cause of such renal trouble was ascertained by Israel in two cases of acute rheumatism with swelling of the joint. One patient suffered from gout, while two passed urine containing an excess of uric acid. In both these cases the blood came from the renal parenchyma, and not from the mucous membrane of the renal calices or pelvis. In one case the first attack followed an exposure to wet weather. In two of the cases the trouble was secondary to inflammation elsewhere (perimetritis, appendicitis); one patient had syphilis, one a movable kidney, while three suffered from attacks of renal colic without any ascertainable cause.

To these causes as given by Israel may be added infection by bacterium coli and alcoholism. Israel's conclusions are well worth considering. They are:

1. Nephritis may be unilateral.
2. Renal colic similar to that produced by calculus may be produced by nephritis.
3. A patient may suffer from nephritis of both kidneys but have pain on only one side.
4. A nephritis of a severe grade may exist without albumin or casts in the urine.
5. The urine may remain free from albumin even though it contains hyaline, granular, and epithelial casts.
6. Nephritis may be accompanied with attacks of profuse hemorrhage.
7. Nephritic hemorrhages may or may not be accompanied with colic; in any case the hemorrhage is not the cause of the pain, both being signs of a renal congestion.
8. A number of cases which have previously been described as renal neuralgia or neuralgic hæmaturia are really cases of nephritis.
9. Incision of a kidney often exercises a favorable influence upon nephritic processes.
10. Anuria due to acute nephritis may be relieved by incision of the kidney.
11. The incision in the kidney should not be sutured.

Careful investigation has thus limited the field of renal neuralgia, just as it limited the field of essential renal hemorrhage. But there remain a certain number of cases of renal colic which cannot be explained upon anatomical grounds. Legueu and Senator described a symptomatic and an idiopathic form of the disease. The symptomatic

form develops as the result of some other disease, for example, disease of the heart and aorta, or of the intestine, or of the prostate, or of the bladder or the spinal cord or the other kidney. Attacks occurring in hysteria and malaria are included by Legueu among the idiopathic cases, while Senator would restrict this term to those cases in which no disease can be found either in the kidney or elsewhere. Senator says that idiopathic cases occur chiefly among women, and Legueu says that the hysterical cases are commoner among men.

SYPHILIS OF THE KIDNEY.

Syphilis may appear in the kidney in the form of gummata, of diffuse nephritis, or of amyloid degeneration.

The gummata may develop in the cortex or in the pyramids. They are of varying size and number. They begin in the interstitial tissue and press aside the tubules, and in their macroscopical appearance they look like tubercular foci or hemorrhagic infarcts in the retrogressive stage. The color of the gumma is yellowish and its centre is almost always soft. Sometimes three zones can be differentiated, a central one of caseation containing fatty degenerated cells and numerous leukocytes, a middle zone marked by the growth of connective tissue and strangulation of the tubules, and an outer zone showing the most recent stage of the process. In this outer zone the epithelium of Bowman's capsules and the tubules is cloudy, and there is an infiltration of small cells. Recovery from a gumma may take place through the development of scar-tissue.

Diffuse syphilitic nephritis is marked in its earlier stages by fatty degeneration of the epithelium. It soon leads to the condition of renal disease known as "large white kidney." Later it leads to contraction of the kidney. It may be unilateral, or even partial in one kidney.

The kidney may be affected by congenital syphilis.

Neither the diffuse parenchymatous nephritis nor the contracted kidney of syphilis possesses any surgical interest. The former gives the ordinary symptoms of acute Bright's disease, usually without pain. The latter is marked by its stealthy progress. It rarely produces polyuria, and gives only faint traces of albuminuria.

A diffuse syphilitic nephritis may lead to thickening of the renal capsule and a dense perinephritis, thus giving a mass which can easily be mistaken for a malignant tumor. The same condition may be caused by renal gummata. Furthermore, the syphilitic tumor may soften in spots, break through the skin, and discharge caseous and necrotic masses for a long time, thus simulating tuberculosis.

If renal syphilis is suspected, the liver and spleen should be carefully examined, since they are frequently involved. The general condition of the patient may be good if amyloid degeneration does not exist, or even without this he may suffer a great deal in general health.

All writers agree that mercury must be given with great caution,

since its elimination through the kidneys is much interfered with by their diseased state; thus symptoms of poisoning will be produced more easily than under ordinary circumstances.

Surgical treatment will only exceptionally be needed. If a gumma breaks through the kidney, or if it completely destroys the kidney, operation will be indicated. In doubtful cases nephrotomy will show just how extensive the disease is. The surgeon will then be in a position to perform a partial resection, or carry out such other operative measures as the case demands. At the same time the patient should be put upon antisyphilitic treatment.

ACTINOMYCOSIS OF THE KIDNEY.

The kidney may become involved in actinomycosis, but this is a very rare localization of the disease, and one which is not likely to be detected except at autopsy.

PLATE X.

Actinomycosis of the Kidney. AT, Actinomycotic Nodule. (Israel.)

CHAPTER XVI.

TUMORS OF THE KIDNEY AND OF ITS PELVIS.

The kidney and the tissues immediately about it are often the seat of new growths of various sorts, which may begin in the renal tissue proper or in that of the renal pelvis, or in the fatty capsule or in the suprarenal gland. Some of these tumors surely develop from portions of suprarenal gland or Wolffian body which have been misplaced in the renal tissue. Then there are cystic tumors which are to be looked upon as retention-tumors.

Renal tumors are easily classified according to the apparent tissue from which they develop. This will divide them into three groups, according as they develop from preformed connective tissue, from preformed epithelium, or from misplaced bits of heterologous tissue. To these three classes must be added a fourth which shall contain the retention-tumors, and a fifth for the parasitic cysts. The tumors of the first group are: fibroma, lipoma, osteoma, chondroma, angioma, lymphangioma, sarcoma, angiosarcoma, endothelioma, perithelioma, and combinations of these different forms. In the second group are adenoma, cystadenoma, adenocarcinoma, and carcinoma. In the third group are hypernephroma and the embryonic glandular tumors of childhood, including rhabdomyoma. The fourth group comprises polycystic renal degeneration and solitary renal cysts. Echinococcus cysts make up the fifth group. Such a pathological classification is simple and clear, but it does not meet the requirements of a surgeon, for each of the first three groups contains some tumors which are benign and others which are extremely malignant, while the cystic tumors of the kidney which clinically belong together are separated by this classification. Hence, for practical purposes it is better to use the old classification, and to divide solid tumors into those which are benign and those which are malignant, to consider hypernephromata separately, and to group together all of the cystic tumors. Before doing this it is worth while to notice some general characteristics of all renal new growths.

Tumors of the kidney which possess a clinical significance belong to two periods of life. They may occur, first, in infancy and early childhood, some of them being congenital and some acquired; and secondly in adult life; that is to say, after the thirtieth and generally after the fortieth year. This division is of especial importance since malignant tumors are not often seen in the period of life in which tuberculosis is especially common. The tumors which occur in infancy are for

the most part described in the sections devoted to embryonic glandular growths and to polycystic degeneration.

Malignant tumors of the kidney occur more frequently in men than in women. Israel found that twice as many women as men consulted him for inoperable malignant tumors. This apparent discrepancy may be explained by the greater amount of room in the abdominal cavity of a woman who has borne children, so that a tumor would naturally grow to a greater size before causing annoyance. Furthermore, the presence of blood in the urine is less likely to cause remark in the case of a woman, and a blood-clot is more easily passed through the female urethra than through that of a man. The chief sign of the development of a renal tumor is the presence of a solid mass in the lumbar region. It is to be remembered that a tumor may grow to a considerable size without being noticed by the patient, and without being found by the physician even though the patient be examined with reference to its presence. It makes a great difference in what portion of the kidney the tumor is situated and what its shape may be. Tumors occurring in the posterior surface of the kidney, or in its upper pole, or anywhere in its upper half, are so concealed by the ribs and thicker soft parts that they cannot be palpated. They may displace the normal lower pole of the kidney downward so that it becomes palpable even though the tumor is not so. An infiltrating carcinoma which may grow through the whole of the kidney without changing its form is specially difficult to diagnosticate. Palpation of the kidney may also be rendered difficult by coexisting enlargement of the liver. On the other hand, tumors which grow in the lower pole or on the anterior portion of the kidney and rise above the level of the normal renal surface are easily detected by the finger of one experienced in renal diagnosis. Thus Israel, who examines a patient in a position midway between dorsal and lateral decubitus, has been able to find a tumor no larger than half a cherry. Schede recommends that the tips of the index and middle fingers of the hand, which in examination is placed anteriorly, be pressed gently in under the margin of the ribs at the moment when inspiration changes to expiration. At this moment the abdominal muscles are relaxed. At the same time that the finger-tips are pressed into the ribs, the hand which is placed posteriorly should press the kidney forward. With each expiration the fingers should sink in a little deeper in order to prevent the kidney, which sinks down during inspiration, from returning to its normal position.

If a malignant tumor can be felt, it is usually recognized as an irregularly round hard pebbly mass. Smooth areas of the surface may represent places where the normal renal tissue has been pressed to one side by the growth of the tumor, but there are also forms of malignant growth of the kidney which have a smooth surface. It is difficult to differentiate such a tumor from an echinococcus cyst or from a uronephrosis without the help of other signs, such as the character of the

aspirated fluid. A cyst of degeneration which sometimes forms in a malignant tumor contains bloody fluid mixed with detritus, or a clear fluid containing a large percentage of albumin. Hæmaturia is one of the earliest symptoms of a renal new growth. According to Chevalier, it is the first symptom in 26.6 per cent. of the cases. The signs which point to a renal origin of the blood have been described. A cystoscopic examination will usually establish the source of the hemorrhage. It is to be borne in mind that a tumor of the bladder and one of the kidney may coexist, or that a tumor of the kidney may exist with a stone in the bladder or a stone in the opposite kidney.

The subjective symptoms of hemorrhage will vary according to circumstances. Thus, if a hemorrhage into the parenchyma or pelvis tightly stretches the renal capsule or forms a blood-clot which obstructs the urine, it will give rise to a more or less severe attack of colic. If the blood clots in the ureter, such clots will be passed with more or less pain. They resemble earth worms in appearance, and even their passage through the urethra is extremely unpleasant. In some cases shorter and fresher clots may be formed in the urethra and passed with the urine. If clots have passed which appear old and bleached, while the urine is clear, they surely come from the ureter. Sometimes the urine is dark red, almost like pure blood, while at other times it is brownish from admixture of blood which has lain some time. Israel says that soft whitish or pale yellowish or reddish clots as large as a maggot or somewhat larger are pathognomonic of renal tumor. Such a clot has a fibrinous skeleton which is filled in with cells, reddish-white blood-corpuscles, detritus, and formed globules.

Even though the urine appears free from blood, microscopical examination will often show that it contains red blood-corpuscles and leukocytes, renal casts, and epithelial cells of different sorts, usually showing inflammatory changes brought about by pressure of the tumor upon the renal tissue. The urine generally contains albumin, partly on account of the degeneration due to this pressure, partly on account of the blood which is present, and partly on account of transudation from the tumor.

It is usually impossible to find any special cause for the hemorrhage. This is characteristic of hemorrhage accompanying a renal tumor. It may appear suddenly without any external cause, and disappear under similar conditions. Naturally it is not impossible for hemorrhage to follow some traumatism, such as a heavy jar, or if it already exists, it may be influenced by such obvious causes.

There may be an attack of colic without hemorrhage; thus a parenchymatous hemorrhage may not reach the renal pelvis or the pain may be due to congestion, either arterial or venous, or to obstruction to the flow of urine. Indeed, local pain is mentioned in most of the cases, perhaps in 80 per cent. of those occurring in adults, and still more frequently in those cases which occur in children. Chevalier says that pain is the initial symptom in 28 per cent. of adults and 7 per cent.

of children. Irritation of the bladder with tenesmus is also a symptom mentioned.

The French writers lay especial emphasis upon the existence of a varicocele upon the affected side. But this occurs in only a minority of cases. Schede did not find it in 20 cases of renal obstruction, and Israel only twice in more than 60 cases. Varicocele is wanting in all small tumors and in the case of most large tumors. Such a varicocele is supposed to be due to pressure of the tumor or affected lymph-glands upon the spermatic vein; but this symptom is not mentioned in connection with such large renal tumors as suppurative kidney, calculous nephritis, etc. On the other hand, Israel and others have seen the renal vein and the vena cava closely surrounded with masses of diseased lymph-glands without varicocele. Héresco points out that a varicocele may disappear after operation although no enlarged glands were observed at operation. The permanence of the cure pointed to the absence of affected glands. Thus, the occurrence of varicocele in connection with renal tumor requires further explanation.

Methods of Growth.—A tumor of the kidney may grow in various ways according to its different structure. Thus it may grow through the capsule and extend directly into the neighboring organs. Or it may grow by metastasis through the lymph-vessels (especially carcinoma), or by extension into the renal veins and vena cava (especially hypernephroma and angiosarcoma), or by metastasis through the blood-vessels (sarcoma), or it may extend to the ureter and bladder by means of the urinary current. Unfortunately, it is often impossible to determine the time and method of the extension of the tumor. Neither the size of the original tumor nor its duration indicates much as to the beginning of the secondary process. For example, it is certain that a hypernephroma may exist for many years as a benign tumor and then suddenly take on a malignant character. The same may be true of a sarcoma. For this reason it has been the good fortune of Schede, Israel, and others to remove with success malignant tumors which had existed eight or ten years.

The success or failure of a proposed operation cannot therefore be predicted from the size of the tumor or from the time which the symptoms have lasted. It is more important that the tumor is still movable. If the fatty capsule has already become adherent, due to a growth through it of the tumor, a complete operation is impossible.

If a malignant renal tumor grows into one of the large veins, it may set up a thrombosis extending into the vena cava. In other cases the lymph-glands which lie close to the renal veins and the vena cava are early affected and adhere to and compress the vessels. This process is similar to that which affects the axillary vein in mammary carcinoma. If there is congestion of the veins of the abdomen, of the thigh, and of the scrotum, it is fair to infer that irreparable damage has been done to the circulation, and operation should therefore be avoided.

The condition of the second kidney is of great importance, but in case of a malignant tumor of one kidney the function of that organ will usually have been lost, so that it may be sacrificed without the exact proof of the functional capacity of the other kidney which is demanded before a kidney is extirpated for other causes.

Treatment.—If a kidney is the seat of a malignant tumor, the proper treatment is its removal. Any attempt at partial resection should be carried out with the greatest caution. Counterindications for operation are: immobility of the tumor, metastasis, disturbance of the venous circulation dependent upon the vena cava, and such general conditions as make impossible any extensive operation.

The kidney should be removed through a lumbar incision for the reasons stated in the discussion of Renal Extirpation. In other cases the whole fatty capsule should be removed. The surgeon should make as clean a dissection as possible in order to avoid by rough handling the driving of little tumor masses into the blood-current.

Results of Operation.—The immediate results of operation have much improved in the last ten years. According to Chevalier, the operative mortality of nephrectomy for malignant tumor up to 1890 was 62.6 per cent., while Héresco found a mortality of 19.3 per cent. for the nephrectomies performed from 1890 to 1899. It is not likely that the mortality will be reduced much below these figures. The removal of a large renal tumor is an operation requiring a considerable time for its performance, so that the injurious action of the narcotic upon the heart and lungs will sometimes prove fatal. It is not always possible to recognize the existence of metastasis. We are fortunate in possessing exact methods of diagnosis of the functional capacity of the other kidney, and the present operative technic is well-nigh perfect. According to Israel, half the deaths which occurred since 1890 (18 of 34) were due to heart failure. Therefore the hope of reducing materially the mortality rests largely upon the use of a less dangerous narcotic.

After these general remarks it is well to describe separately the different classes of tumors.

BENIGN TUMORS OF THE KIDNEY.

Of the various forms of benign tumors which develop in the kidney, angioma, lymphangioma, osteoma, and enchondroma are of interest chiefly to the pathologist. As they never reach a large size and give rise to no symptoms their presence is never recognized, and they never require surgical treatment.

On the other hand, a lipoma, or a fibroma, or an adenoma, or a tumor composed of a mixture of these elements may reach a considerable or even an enormous size, and may therefore require operative treatment.

A true lipoma of the kidney develops either from the fatty and fibrous capsule of the kidney or is due to misplacement of portions of

fat in the renal tissue proper. Such a misplacement may occur during embryonic life. A lipoma consisting simply of fat is rarely seen. It usually contains a mixture of fibrous or myxomatous tissue, and even in a lipoma of the kidney which appears to be pure there can usually be found a few smooth muscle-fibres.

Lubarsch and Manasse have given the name lipomyoma to a tumor as large as a hen's egg, or smaller, which is made up of fat and smooth muscle-fibre, in parts of which the grouping together of connective-tissue cells and giant cells suggests that the tumor is in a transition-stage to sarcoma.

Lipoma of a capsule is, on the whole, a rare tumor, less than 20 cases having been reported; 14 patients were operated upon, of whom only 6 recovered; but as most of the operations were performed many years ago, this mortality has no significance at the present time.

A lipoma of the kidney itself is usually a small rounded or lobulated tumor situated immediately under the fibrous capsule in the cortex of the kidney. It is easily recognized at a glance. It owes its origin to a misplacement of a portion of the fatty capsule, and is therefore a heteroplastic tumor. (Virchow.) Grawitz is of the opinion that the renal cells also take part in the formation of the tumor. As they are pressed aside by the growth of the lipoma, the interstitial tissue of the kidney forms a sort of capsule, and these cells by taking up fat may become cells of the lipoma. Alsberg mentions a case in which one kidney of a woman aged forty was the seat of multiple lipomata varying in size from that of a millet-seed to that of a walnut. The kidney together with the tumors was as large as a child's head, and was successfully extirpated.

Some writers class as lipomata little whitish tumors which are found in the cortex close beneath the fibrous capsule. On section they look like a soft cancer, and their cells contain large drops of fat. Grawitz has shown that these fatty cells are for the most part not of the connective-tissue type. After the fat has been extracted the cells are seen to be polygonal or cubical, or of irregular shape suggesting an epithelial origin. The intervening tissue is composed of homogeneous or fibrillary connective tissue which here and there suggests a delicate alveolar stroma. The structure of these tumors is therefore more like that of an adenoma or even a carcinoma or sarcoma, and they have therefore been frequently described as adenomata or adenocarcinomata. Grawitz believes that they develop from misplaced bits of suprarenal gland. They are described fully on page 361.

A pure fibroma of the kidney has never been described. There have been a few instances in which a cystofibroma, or a myxofibroma, or a fibromyoma has reached a large size. The symptoms are such as those caused by any large solid tumor of the kidney, and the correct pathological diagnosis is therefore not likely to be made until the tumor has been removed. Under certain circumstances it may be possible

to remove such a tumor while preserving the compressed and atrophied renal tissue.

An adenoma is usually a small tumor found for the most part in a chronically inflamed kidney. It is white or yellowish, and is generally situated on the surface of the organ, but it may be more deeply placed in the parenchyma. Several or many adenomata may coexist. These tumors may be separated from the renal tissue by a thin connective-tissue capsule, or such a capsule may be wanting. In rare cases multiple adenomata may form a large tumor without change in microscopical structure; if so, the kidney is more or less destroyed.

Microscopically an adenoma shows an exquisite glandular structure. There may be tubules with an irregular lumen, round, with small cylindrical or cubical deeply staining cells; or simple round alveoli with a single layer of epithelium or other alveoli whose walls show projections made up of two rows of cells, or some alveoli of more complicated form in which between the rows of cells there is a connective-tissue framework. Sometimes this glandular structure is carried out to its fullest development, with dendritic branches alternating with cauliflower-like growths.

Sometimes the tubular new growth can scarcely be distinguished from normal tubules into which it passes insensibly. But the cells of the new growth will always take a deeper stain than those of the pre-existing tissue. Little cysts may be found in the tumor containing desquamated epithelium, pigment, and small concretions of lime salts. If the size and number of such cysts warrant it, the name cystadenoma may be given to the tumor. An adenoma of the kidney may develop into a carcinoma. If so, different portions of the new growth will show the various steps in the change from a slight proliferation of the epithelium of the tubule with the preservation of its lumen, to a complete filling up of the lumen with cells and the formation of true carcinoma cell-cones. While admitting the malignant degeneration of an adenoma, the relation of an adenocarcinoma to a true carcinoma is by no means clear.

MALIGNANT TUMORS OF THE KIDNEY.

Carcinoma.—Primary renal cancer presents itself macroscopically in two forms, according as the nodules of the tumor are scattered through the renal parenchyma, or as the tumor infiltrates diffusely the whole kidney. The two forms are spoken of as nodular and infiltrating. Cancers of the kidney are also divided into soft and dense tumors according to the relative absence or abundance of connective tissue.

The origin of carcinoma of the kidney was ascribed by Waldeyer to the preformed tubules. Such development Lissard and Manasse believe they have observed. Sudeck and Manasse concluded from their investigations that the nodular form of primary renal carcinoma

is similar in structure to an adenocarcinoma, and has cylindrical or cubical cells, while the cells of the infiltrating carcinomata are from the beginning oblong or irregular, and often form with the cells of the neighborhood a common protoplasmic mass containing numerous nuclei. They fill the dilated tubules in a short time and change them to solid strings, and then break through the basement-membrane of the tubules and sprout in the surrounding tissue in the form of solid-celled cones. There are no new-formed hollow glandular processes.

Graupner disputes the idea as given by Manasse that an infiltrating carcinoma originates from the epithelium of the urinary tubules. If such were the case, the epithelial cells of the tubules ought to show mitotic figures, and these have never been observed. Neither have there been seen any tubules in the stage of transition from the normal condition to that of carcinoma. On the contrary, all investigators emphasize the fact that the arrangement of the cells in a carcinoma is wholly in solid strings, and thus this tumor is sharply contrasted with an adenocarcinoma which certainly develops from the tubules. Therefore at present we are wholly in the dark as to the origin of the infiltrating carcinoma. Graupner has called attention to the fact that the oldest nodules are situated in the vicinity of the renal pelvis. These nodules possess an anatomical character similar to that of a flat-celled cancer. Israel mentions a case of carcinoma of the kidney which certainly developed from the renal pelvis, and in which the cells also resembled those of a flat-celled cancer.

Graupner sums up the subject by saying that infiltrating carcinoma begins in the neighborhood of the renal pelvis, and spreads in the lumina of the tubules, and also in the interstitial tissue, until it reaches the surface of the kidney. The shape of the kidney is therefore preserved while its size is increased. The cells grow in solid strings from the first. They are quite unlike the cells of the tubules, but resemble those which line the renal pelvis. While the tumor is making its way outward toward the surface of the kidney masses of the tumor may grow into the renal pelvis, and ulcerate, and thus give rise to profuse hemorrhage.

Graupner states that a nodular carcinoma develops from the urinary tubules. In some cases at least a typical adenoma is first formed, which later changes into an adenocarcinoma. Such an adenoma is not encapsulated, and is made up of spaces which are lined with epithelium similar to the epithelium found in fœtal urinary tubules. Whether these nodules are remains of fœtal tissue or whether they are due to a retrograde development in the existing tubules is not determined. The capsule of an adenoma is a secondary formation due to the irritating effect of the tumor upon the surrounding tissue. It affords no security against extension of the tumor, since as soon as the carcinomatous type is well developed the cells readily break through the capsule. Adenoma and likewise adenocarcinoma develop especially in the cortex, and only reach the pelvis when they become of large size.

PLATE XI.

Adenocarcinoma of the Kidney. (Wyss.)

Carcinoma of the kidney is not characterized by any striking symptoms, and one can scarcely hope to make a more exact diagnosis than that a malignant tumor exists. Such a condition may be suspected when the kidney presents itself as a solid tumor and when the urine contains blood and particles of tumor-tissue. Naturally there may be pain and pressure in the region of the kidney, but these symptoms are in no sense characteristic.

All these signs may be wanting. An infiltrating carcinoma may completely destroy the kidney without increasing its size or altering its form. Furthermore, hæmaturia may be wanting in the case of an

FIG. 128.

Carcinoma of the kidney, the lower pole being apparently uninvolved. (Wyss.)

adenocarcinoma, so that the urine may continue to be normal. The tumor may not be recognized until constant pain in the lumbar region and gradually increasing cachexia lead the surgeon to expose a kidney. Operation will then usually be too late.

If a tumor can be felt, it will as a rule be found to be hard and nodular. If there are hemorrhages in the tissue, or areas of secondary softening, or if the new growth is of a medullary character, there may be either in places or everywhere a feeling of fluctuation.

Rohrer analyzed the records of 115 cases of primary renal cancer, and found that in 36 cases no tumor was present, and there was no hæmaturia; that in 12 cases there was no tumor, but there were such symptoms as hemorrhage and pain; that in 25 cases there was tumor with hæmaturia, while in 42 cases a tumor was present without hemorrhage. This analysis was made at a time in which hypernephromata

were not recognized as such, and in which renal tumors in children were not sharply differentiated from those in adults; therefore Rohrer undoubtedly included in his list many tumors which to-day could not be classed as carcinomata. Chevalier's statement is much more reliable. It is that hemorrhage occurs in 75 per cent. of all cases of renal carcinoma. The development of new methods of palpation have doubtless increased the percentage of palpable tumors considerably above the figures given by Rohrer.

Sarcoma.—Sarcoma of the kidney is usually spindle-celled, or large- or round-celled, and may exist as a single compact tumor, or there may be multiple tumors. Sometimes giant cells have been observed. The mixed form of sarcoma, such as fibrosarcoma, myxosarcoma, and chondrosarcoma, also occur and have the characteristics which they exhibit in other portions of the body. The malignity of renal sarcoma varies greatly according to its cellular structure. Some of these tumors are solid, and relatively benign, while others are soft and others malignant. There may be hemorrhage into the tumor and retrogressive metamorphosis which change its appearance and its physical characteristics.

Simple sarcoma of the kidney may occur at any age; it is far less likely to give rise to hemorrhage than is carcinoma. According to Chevalier, hemorrhage occurs in about 50 per cent. of all sorts of renal sarcomata in adults.

Angiosarcoma, Endothelioma, and Perithelioma of the Kidney.—It has only recently been emphasized that a number of new growths owe their origin to proliferative processes of the cells of the lymph-vessels and bloodvessels. The cells involved may be those of the endothelium or of what Eberth calls the perithelium. The latter are large nucleated granular cells with numerous fine processes which lie outside of the bloodvessels, and are identified, according to Waldeyer, with the cells of the adventitia. Different observers, however, are not agreed upon this classification. Kolaczek classes every sarcoma, whether starting from within or without the vessels, as angiosarcoma. It has been suggested that the perithelial cells of the bloodvessels are really endothelial cells of the lymph-spaces outside of the bloodvessels, but this is not proved. Hippel employs the term hæmangiosarcoma for all tumors starting from the bloodvessels, and lymphangiosarcoma for those starting from the endothelium of the lymph-vessels.

Perhaps the best classification for the present, at least, is a division of angiosarcomata into endothelioma of bloodvessels, endothelioma of lymph-vessels, and perivascular sarcoma. The last group might also be called perithelioma if one accepted Eberth's definition of adventitia cells.

a. An endothelioma of the bloodvessels is a rare tumor. The endothelial growth may begin in the capillaries or in the smaller veins. There will appear sprouts which terminate blindly and often in a fine point. Such a sprout contains a lumen and is full of blood. The

capillaries are also much enlarged, and the cells of the capillaries and veins extend into the lumen and stain deeply, so that they look almost like epithelial cells. Sometimes they block the lumen. There are also dilatations in the veins filled with pigment, blood-corpuscles, and fragments of cells. Such dilatations may later be filled with sprouts from the cells which line it. These sprouts may branch and intertwine with each other, and their cells may lose their endothelial character and become cubical. Hyaline degeneration, necrosis, and the formation of cysts are processes also found in such a tumor.

b. An endothelioma starting from the lymph-vessels is more often seen. This is a tumor with a definite structure. It has a connective-tissue stroma filled with a fine network of regularly branching strings of cells which represent lymph-vessels filled with tumor-cells. Sometimes isolated lymph-vessels are seen which are also filled with proliferated endothelial cells, and which are easily recognized as lymph-vessels by their sinus-like dilatations, by their valves, and by their relation to the arteries. Even the little lymphatic clefts or lymph-spaces are generally filled with the tumor-cells.

Examination of the growing portions of such a tumor will prove that it is not a carcinoma but an endothelioma. In such a portion one can observe how the normal endothelium gradually changes into a layer of such cells as are found in the older portions of the tumor. Furthermore, in a carcinoma it is possible to demonstrate that the lymph-spaces which are filled with tumor-cells may retain their own endothelium. In an endothelioma starting from the lymph-vessels such a condition is impossible.

In its later stages an endothelioma shows a true alveolar arrangement. There are larger and smaller spaces corresponding to lymph-cysts, which are filled with tumor-cells. Papillary growths spring from their walls, and growing inward complicate the picture just as they do in endothelioma occurring from the bloodvessels.

A differential diagnosis from a carcinoma may be difficult to make, but the net-like arrangement of the strings of cells, the fact that the tumor-cells do not resemble the epithelium of the urinary tubules, and that they do not lie together in such irregular masses as in carcinoma, will usually establish the correct diagnosis.

c. A perivascular sarcoma or a perithelioma also shows in its growing portion the characteristic net-like arrangement of tumor-cells. The skeleton of this network is formed from thin-walled vessels which may contain blood or whose lumen may be obliterated. They are covered externally with a single layer or with several layers of cells. These cells may be of the usual spindle-shaped type or they may be more cylindrical. This network is not imbedded in any tissue, but forms the chief part of the tumor. The latter has in many cases the characteristics of a sponge. As the cells of the adventitia proliferate they fill more or less the meshes of the net, and if they have lost their endothelial character and resemble more nearly epithelium the

appearance of the section of the tumor will be more like that of carcinoma. In older sections of the tumor, instead of the delicate vascular network, there is one made up of connective tissue with scanty nuclei and possessing sometimes a hyaline appearance, but everywhere it is covered with the adventitia cells as described above. The meshes may be full of cells, or they may be empty. The vessels will be more or less obliterated. These tumors are characterized by degenerative processes, either of a hyaline or amyloid character.

Embryonic Adenosarcoma.—Congenital misplacement of a portion of the suprarenal gland in the kidney may develop in later life into a tumor which is called a hypernephroma. But there are other tumors of similar origin which develop very rapidly, so that they may attain a considerable size either at birth or in the first two or three years of life. Some of these tumors are sarcomata, some carcinomata, some rhabdomyosarcomata, etc., but in none of them is found the typical arrangement of the sarcoma or the carcinoma developing in extra-uterine life. The form and arrangement of their constituent parts suggest rather an active growth of a mixture of glandular and embryonic connective tissue. The type of the tumor will vary according to the relative amounts present of these two tissues, and differences will be found not only in different tumors, but also in different parts of the same tumor, so that one section will look like an adenoma, another like a carcinoma, and others like mixtures of glandular and sarcomatous tissue.

Most of these tumors are made up of the combination of epithelial tissue of the glandular type and smooth and striated cell-fibres in various stages of development, with a more or less perfect stroma. A classification of such tumors according to the predominance of one or the other of these elements is useless, and it is better to include them all under the term of embryonic renal tumors, or sarcomatous glandular tumors of the kidney occurring in childhood. Various names which have been given to them are carcinoma, adenocarcinoma, sarcomatous carcinoma, adenosarcoma, adenochondrosarcoma, myosarcoma, and rhabdomyosarcoma.

The development of these tumors is quite different from that of the ordinary carcinoma. In the first place, they occur in early childhood. They are further characterized by a growth which is at first slow but later very rapid. They affect neighboring organs slowly by mechanical pressure. Necrosis of portions of the tumor may produce general symptoms. Such a tumor seldom spreads to the neighboring tissue, and has little tendency to form metastases. If it does spread, it resembles a hypernephroma in the fact that it seldom affects lymph-glands but rather breaks into the blood-current. The typical extension of cones of epithelial cells into the surrounding tissue which is so marked a characteristic of carcinoma is wholly wanting, and the glandular portions of the tumor are sharply differentiated from the healthy renal tissue. The latter may atrophy as a result of pressure.

A complete development of glandular structure is wanting in one of these tumors. Epithelial and sarcomatous elements grow side by side, and the embryonic character of the growth is shown by this fact as well as by the stroma, which is composed in large measure of embryonic connective tissue. Wilms has recently published an important article on this subject.

Döderlein and Birch-Hirschfeld believe that these tumors have nothing to do with the renal tissue proper, but may develop from remains of the Wolffian body. Wilms believes they spring from mesoderm before this has given origin to the fore kidney. Ribbert considers that the epithelial elements come from the epithelium of the renal pelvis, in spite of the fact that Perthes has shown that these elements may exist in a tumor which has not reached the renal pelvis. Brosin believes they develop from the lymph-vessels, and that their epithelial elements are really endothelial.

These embryonic glandular tumors form a characteristic group which is sharply differentiated from that of the malignant hypernephromata. The latter tumors occur almost exclusively in patients who are at least thirty or forty years old, while the former occur in childhood, and especially in infancy. Their occurrence from the eighth to the tenth year is a rarity, and there is only one instance of such a tumor occurring in a child as old as fourteen years. Hypernephroma grows slowly, while the embryonic glandular tumors of children grow with great rapidity. An early symptom of hypernephroma is hæmaturia. This is almost never an early symptom of an embryonic glandular tumor and, according to Chevalier, it does not occur in more than 25 per cent. of these tumors at any stage. The patient is usually brought to the physician on account of the size of the tumor, at a period when any possible relief from operation is no longer possible. Since these tumors have little tendency to form metastases, and since they do not lead to amyloid degeneration of other organs, the results from operation at an early stage ought to be rather good. Thus, Albarran found a mortality of only 30 per cent. in 97 nephrectomies performed upon children for this purpose. Eleven of the patients who recovered were known to be free from recurrence for a year or more. Of course, this time is not sufficient to guarantee that the cure is permanent.

HYPERNEPHROMA.

Under the head of lipoma it was mentioned that Grawitz has shown that the little fat-like tumors which lie immediately under the fibrous capsule of the kidney develop from misplaced fragments of suprarenal gland. He holds that these fragments may be the starting-point for both benign and malignant tumors of sarcomatous or carcinomatous nature. This theory of Grawitz has been the starting-point for numerous investigations, but even now the pathology of these tumors is by no means so clear in all respects as one might wish.

On pulling back the capsule from the cortex of the kidney one often finds these fragments of suprarenal gland, which may be of almost microscopical size, or as large as a pea or bean. An examination of their structure will invariably show the characteristic arrangement of cells which is found in the suprarenal gland. As the suprarenal of a three-months' old fœtus is considerably larger than the kidney and surrounds it almost everywhere, an abundant opportunity is afforded for the persistence of misplaced portions in the renal substance.

Fig. 129.

Hypernephroma of kidney. (Wyss.)

The microscopical appearance of one of these tumors is very characteristic. It shows a delicate vascular stroma, within the meshes of which are strings or groups of polygonal cells whose bodies contain few or many fat-drops. These cells are quite different from the epithelial cells of the convoluted tubules, and therefore the name adenoma cannot properly be employed. Furthermore, the strings of cells have no lumina, and they closely resemble, both in their structure and in the character of the cells which compose them, the nodules which

develop in the suprarenal gland. Therefore the chain of evidence seems complete as proof that these tumors develop from misplaced fragments of suprarenal gland. They are also stained yellowish or brownish with a solution of potassium bichromate, a reaction which is peculiar to the medullary portion of the suprarenal gland. Other points of resemblance are the hemorrhagic centres and areas of myxomatous degeneration which are found in these tumors. Clear as this

FIG. 130.

Hypernephroma of kidney. (Wyss.)

proof appears to be, it is not accepted by all observers, and these tumors have been held to develop from preformed epithelium and from preformed endothelium, as well as from misplaced fragments of suprarenal gland. This only shows how difficult an exact pathological classification may be. The origin of any tumor is best shown by the character of its growing portions, and if proof of this sort cannot be obtained

because a tumor is already well developed, it is better to suspend judgment rather than to insist upon placing it in a class to which it does not belong. Von Ricker, who made serial sections of the tissue of one of these tumors, together with the adjacent renal tissue, found that in places each grow into the other. This suggests the possibility that a true renal tumor may develop within a fragment of misplaced suprarenal gland, and that, if so, the new growth may not necessarily come from the fragment of suprarenal gland, even though it is intimately associated with it.

In the light of our present knowledge, the subject of hypernephroma may be summed up as follows :

1. Small tumors situated in the renal cortex and containing fat which are wholly composed of tissue resembling the cortex or pigmented zone, or even the medullary portion of the suprarenal gland, are to be considered misplaced fragments of that gland rather than tumors.

2. Accessory glands of the true type may occur in the form of larger lobulated tumors containing fat and having a whitish, yellowish, or brownish color, and solid consistence. They are found beneath the capsule of the kidney, usually at the upper pole, and are divided by connective tissue into smaller and larger lobules, and are separated from the renal parenchyma by a connective-tissue capsule. Microscopically the tumor is seen to be made up of a fine connective-tissue stroma consisting generally of capillaries and small veins. The meshes of this network contain characteristic cylinders or groups of cubical or rounded or polygonal cells of the epithelial type. The cylinders of cells are often disposed parallel to one another. In some places their diameters may be small like that of the cellular columns of the suprarenal gland, while in other places the cylinders will be found enlarged so as to form club-shaped processes, but nowhere is there any trace of a lumen to be seen. The cells are all about the same size. Their nuclei stain well, and their bodies contain numerous fat-drops and also glycogen, as shown by the brown color produced by iodine. Such a tumor is analogous to an adenoma of the suprarenal gland, and is to be looked upon as hyperplasia of the misplaced suprarenal substance. A hypernephroma of this character is a benign tumor.

3. There are other hypernephromata which are characterized by the appearance of growth not only of a group of cells, but of the individual cells. This growth in places leads to the development of giant cells with large irregular nuclei which cannot be identified with the cells of the suprarenal gland. Manasse calls attention to the fact that the veins of these tumors are not circular in section, but are three-sided or four-sided.

4. In rare instances tumors develop in the cortex of the kidney which seem to owe their origin to the cells of the medullary portion of the suprarenal gland. Usually these tumors develop from misplaced cells of the suprarenal cortex. Manasse, however, described a tumor the size of an egg almost wholly made up of groups of dark-brown or

brownish or yellowish cells separated from one another by thin connective tissue. Some of these cells were larger, some smaller, and they varied much in shape. While the smaller cells were arranged in rows as in the normal suprarenal, larger ones were arranged in irregular groups.

5. The forms of hypernephroma thus far described are tumors containing solid strings and groups of cells. There are other tumors in which the cell-strings and groups are placed around hollow spaces, thus forming hollow cylinders and cysts. Sudeck believes that these tumors develop from the urinary tubules, and not from misplaced portions of the suprarenal gland. But this opinion is not held by other observers, especially since similar tumors have been found in connection with the suprarenal gland itself.

6. Hypernephroma which shows a tendency to form cysts and tubules must be looked upon as a malignant tumor. However, malignancy may exist with infiltration of the surrounding tissue, invasion of the veins, and the formation of metastases, but without the formation of hollow spaces within the tumor itself.

The structure of a malignant hypernephroma is about the same as that described in paragraph 5. A nodular tumor of yellowish or brownish color with a harder centre and a softer periphery either presses aside the neighboring tissue or infiltrates it and destroys it by the formation of new nodules. Sometimes the tumor grows into the pelvis of the kidney, forming polypi. Portions of the tumor on section appear to the eye translucent, like young cartilage, while in other portions there are evidences of hyaline degeneration. The mass of tumor is made up of connective-tissue stroma whose meshes are filled by cubical or polygonal cells containing fat and glycogen. These cells are arranged in strings and rows suggestive of the arrangement of cells in the liver, or they may exist in broader cones and groups. Sometimes they are arranged in the form of a tubule, or of an alveolus more or less filled with cells and with papillary outgrowths springing from the lining of the spaces. In the older portions of the tumor there are often found cysts of degeneration and hemorrhagic areas.

A malignant hypernephroma is properly classed with the sarcomata in spite of the epithelial character of its cells. This is done because there is no sharp differentiation between stroma and parenchyma, and because the connective tissue which forms the stroma also extends in between the cells of the parenchyma. Furthermore, while the younger portion of the growth looks like an epithelial tumor, the older portions show an appearance typical of sarcoma. For this reason also Graupner holds to the opinion that such a tumor is a sarcoma.

The clinical course of a hypernephroma is for a long time a latent one. Such a tumor grows slowly and may give no symptoms for a considerable time. It is not apt to be noticed until after the fortieth year of life, and the first symptom is frequently an attack of hæmaturia with or without renal colic. Sometimes a feeling of dull pressure

in the lumbar region first directs the patient's attention to his trouble. Even after one or more hemorrhages the tumor may increase in size with great slowness. There are instances in which from five to twelve years elapsed between the first hemorrhage and death or operation. While a patient of Askanazy, aged fifty-four, asserted that he had noticed his tumor from a child, such a benign course cannot be reckoned upon. No one can say how soon the tumor will break through into a vein and give rise to rapid formation of multiple metastases and death. The patient is also in danger from hemorrhage. The soft character of the growth and the delicate walls of its vessels explain the occurrence of early and frequent hemorrhage. Amyloid degeneration of various organs has been mentioned by several writers. The formation of metastases through the lymph-channels is not a common occurrence.

The prognosis of operation will depend upon the time of its performance and the conditions which it reveals. Israel reports 17 operations with 4 deaths. Five of these patients died from metastases. Once he removed a recurrence in the scar. At the time of report 4 patients were living more than two years after operation, and 3 patients more than five years after operation.

CYSTIC TUMORS OF THE KIDNEY.

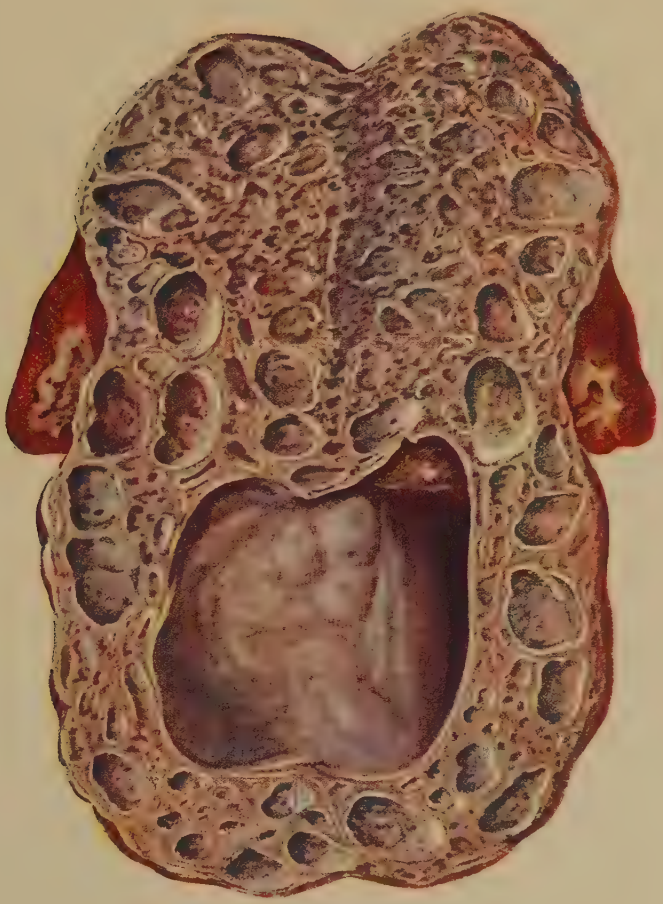
There are various processes which may lead to the development of cysts in the kidney. Cystic spaces may be formed within malignant growths as the result of softening, hemorrhage, etc. There is also a formation of true cysts due to the growth of echinococcus, and also cysts due to degeneration of the kidney itself.

Echinococcus Cysts.—Echinococcus cysts of the kidney are not very common. Some 36 cases are reported as having been treated surgically. The cysts develop slowly without especial pain. The tumor is usually not noticed by the patient until it has reached a considerable size.

The diagnosis is difficult. In most cases it is only possible to say that there is a smooth round movable tumor in the region of the kidney. Sometimes the tumor feels as hard as a fibroma; in other cases there is an indefinite fluctuation or a peculiar vibration. The urine is unchanged unless one of the echinococcus cysts has burst into the pelvis of the kidney. Under such circumstances daughter-cysts and hooks may be found in the urine, thus establishing the diagnosis. In most cases in which a correct diagnosis has been made, it has been on account of such characteristic urinary sediment. The cyst may be confounded with an ovarian tumor or hydronephrosis, or a solid tumor. Diagnosis may be established by puncture, but this is an unwise procedure. It is better to expose the cyst by incision.

Multiple echinococcus cysts in the kidney have never been observed. For this reason, and also because there is invariably a considerable

PLATE XII.



Polycystic Degeneration of the Kidney. (Wyss.)

amount of functionally active renal tissue, the affected kidney should never be removed. The invariable treatment should be incision of the sac and suture of its cut edges into the wound in the abdominal wall. This treatment should apply to suppurative and non-suppurative cysts alike. If the circumstances are especially favorable, partial resection may be performed and the wound partially sutured in order to shorten the period of convalescence.

Sometimes the kidney has been removed for echinococcus cysts. In one instance the kidney removed was the only one. In a case reported by Gerster the cyst was calcified, and on this account the kidney was removed. So far as known, 23 patients have been treated by simple incision, and have all recovered with the exception of one who died of heart failure.

Simple Cysts.—Solitary cysts of various sizes may develop in the kidney. They show little tendency to destroy the renal tissue, and are therefore harmless.

Polycystic Degeneration.—Polycystic degeneration may transform the kidney into a mass of cystic spaces, some of which may reach the size of an apple, while others are so small that they can be seen only with the microscope. This process may go on until the parenchyma is entirely destroyed. This process may be congenital, or it may develop in later life. The principles which underlie it have given rise to much discussion; but it is not yet generally recognized that different pathological conditions may lead to different cystic degenerations of the renal parenchyma of similar macroscopical appearance. When the tissues are studied with a microscope, marked differences are seen which point clearly to a different origin.

The old idea was that in all cases the cysts were retention-cysts due to a stoppage of the tubules with concretions, or by inflammations about their mouths, etc. Later, the idea was advanced that at least some instances of cystic degeneration of the kidney were due to overgrowth of the epithelial cells, followed by degeneration, hence the term "multilocular adenocystoma" was employed. Ribbert holds that some of these tumors are examples of congenital malformation—an embryonic arrest of development.

Microscopical examination in many of these cases shows an active growth on the part of the interstitial tissue about the tubules in the papillæ and around the pelvis of the kidney and the ureter. This process may be so extensive that the tubules are wholly enclosed in a connective tissue similar to that found in the embryo. In the cortex the capsules of the glomeruli will be found dilated, while the coil of capillaries is pressed flat against the wall within. In the early stages the cysts have a rounded shape and are lined with a single layer of low epithelium similar to endothelium. These cysts are without doubt due to obliteration of the tubules.

While the process above described is commonest in young infants, it may also occur in adults. It is a connective-tissue growth which extends

from the ureter and pelvis to the calices and pyramids and strangles the uriniferous tubules. In the newborn it is possible for the process to reach a degree of development which it cannot reach in later life if both kidneys are affected. Still the disease may progress very slowly in adult life. In one adult patient whose health was previously good the process apparently went on for eight years. The first symptom was hæmaturia. In another patient the symptoms lasted for fifteen years, until a typical cystic kidney was extirpated. The cortex was filled with large and small cysts which proved to be dilated glomeruli with thickened capsules. The epithelial cells of the convoluted tubules were swollen in places and obstructed the lumen. Some tubules contained hyaline cylinders. The interstitial connective tissue was hypertrophied. The process grew more intense from the cortex to the pyramids. In them the tubules were constricted by thick bands of connective tissue, and above these constrictions they were dilated.

Adenocystoma.—There is another form of cystic kidney of quite a different origin. In this form the cysts are not confined to the cortex, but extend into the papilla. Here and there a papilla is affected by the disease, and this is also true of the portions of the calices and renal pelvis.

The epithelium of the tubules both in the pyramids and in the cortex shows characteristic changes. The cells increase in size and become tall cylinders, and their nuclei swell until they occupy almost the whole body of the cell. Both the nuclei and the cell-protoplasm stain deeply, thus showing their increased activity. The tubules are dilated.

If one follows a straight tubule in some papilla which is not much altered, he will see that the epithelial tube has loosened itself from the basement-membrane and lies like a twisted snake within the space thus formed. It looks as though the epithelium had grown until there was not space for it in the absolutely unchanged connective tissue. These epithelial cells are cylindrical, and take stain deeply and contrast sharply with the faintly staining cubical epithelial cells of the unchanged tubules in the neighborhood. In other places the epithelium of the tubules is found in several layers, of which the innermost is composed of cylindrical cells and the others of cubical cells. In still other places the epithelial cells have grown into tumor-like masses which project into the tubules, and which are sometimes composed of as many as ten layers of cells. Sometimes the basement-membrane is preserved, sometimes it is lost in the connective tissue.

Other observers mention an abundant desquamation of epithelial cells within the tubules, together with a granulation and colloid degeneration of the cells. These changes are doubtless later ones in the formation of cysts. Other observers speak of changes due to urinary retention and secondary growth of connective tissue. The epithelium of the formed cyst is cubical or cylindrical, and in places is six or eight layers deep. In other places the cyst is lined with a single layer

PLATE XIII.

Cross-section of a Cystic Kidney. (Taylor.)

of smooth cells like endothelium. Such spaces may perhaps be of lymphatic origin. Here and there will be seen polypoid growths extending from the walls into the cystic cavities. The septum between neighboring cysts may be composed of a double layer of epithelial cells separated by a small amount of connective tissue. Sometimes the septum is not complete and the cysts connect with each other. Sometimes normal or atrophic tubules will be found in these septa between cysts.

The epithelium of the cystic spaces is subject to colloid degeneration, and masses of epithelial cells more or less degenerated float in the cyst cavities. Sometimes these degenerated cells are pressed together until they form large masses which may be more or less stratified and show in places the cells from which they originated.

The glomeruli of the kidney affected in this manner either remain uninjured, or the epithelium which lines the capsule changes to a tall cylindrical type. Some of the glomeruli dilate and others collapse. Some observers believe that cysts may develop from the glomeruli, while others doubt this.

Thus it will be seen that although investigators are not entirely agreed as to the details of cystic degeneration of the kidney, it is beyond question that there is a polycystic renal degeneration of the kidney which is quite distinct from the cystic formation due to a growth of connective tissue. In the process just described there is marked proliferation of the epithelial cells and the tubules of the cysts, there are papillomatous growths, the epithelium is in several layers, there are islands of epithelium lying free in the tissue, and there is colloid degeneration of the growing epithelium, and all this with slight if any overgrowth of connective tissue. In the form of cystic degeneration first described there is a loose overgrowth of connective tissue associated with complete collapse of the ureter, renal pelvis, calices, and papillary tubules, and not the slightest trace of epithelial proliferation, while the epithelium which lines the dilated tubules and cysts invariably remains in a single layer. These facts show that although the two processes produce results which are very similar macroscopically, they are quite distinct processes. The second form of cystic degeneration has been spoken of as adenocystomatous new growth. In this opinion many observers agree. They differ in their views of the origin of the process. Some look upon it as a failure of development in embryonic life, and some consider that the remains of the primitive kidney, or of the Wolffian body, grow within the normal tissue and destroy it, while others believe that the cysts develop from existing tubules and glomeruli.

The congenital cases of polycystic renal degeneration possess slight surgical interest, since the affection is almost always bilateral, and the fœtus is therefore incapable of extra-uterine life. However, in a few instances the disease has been confined to one kidney, and under such circumstances, if the diagnosis can be made, extirpation of the

affected organ must be considered. Examination will usually show a large tumor with a rough surface which is generally not to be differentiated from a solid tumor. Such a condition may be of congenital origin, and show itself first a long time after birth. Polycystic degeneration occurring in later life is of greater importance than the congenital variety. Here, too, there is a tendency for the degeneration to exist in both kidneys as well as in the liver, so that operative treatment should be undertaken with great caution. Israel mentions a case of this character in which there was also cystic degeneration in the epididymis. Arteriosclerosis and hypertrophy of the heart are frequently found in conjunction with polycystic renal degeneration.

Diagnosis.—The diagnosis is not an easy one to make. The symptoms usually observed are hæmaturia and a very gradual development of a tumor in the lumbar region, with possibly attacks of renal colic. If the disease is bilateral, even though one kidney is not palpable, the symptoms will frequently be those of contracted kidney with abundant dilute urine containing a little albumin and associated with hypertrophy of the heart. The family history is worth considering in making a diagnosis, since there have been many instances in which polycystic degeneration of the kidney occurred in more than one member of the same family.

Sometimes it is possible to make a probable diagnosis of unilateral polycystic degeneration by careful attention to all the symptoms, and by exclusion of other renal troubles. The extremely slow development of a tumor after the first attacks of pain or hæmaturia is a suspicious symptom. This period of time may extend for ten or fifteen years. The surface of the tumor is pebbly, and fluctuation can sometimes be made out in the larger cysts. If a tumor has existed a long time without cachexia, it is probably not malignant. If it is too solid for a hydronephrosis or an echinococcus cyst, or the rarely seen solitary cysts, and if there is no suspicion of pus or calculus, the condition is probably one of polycystic degeneration, even though the symptoms are confined to one side. Retroperitoneal aspiration may empty a single cyst and furnish clear serous, or darker colloid, fluid which contains fragments of degenerated epithelial cells. If there are tumors in both loins and palpable cysts in the liver, in association with symptoms of cicatricial kidney, arteriosclerosis, and hypertrophy of the left ventricle, the diagnosis of polycystic renal degeneration is well-nigh certain.

Treatment.—If the trouble is bilateral, curative treatment is impossible. It is conceivable that intense pain, or free hemorrhage, or discomfort due to the mere size of the tumor, might be overcome by treatment. Thus, nephrotomy with the opening of a number of the larger cysts, or multiple puncture of a great many of the cysts, might be of service, but such treatment so far as known has never been carried out.

Operation has several times been performed when the surgeon be-

lieved that the trouble was unilateral. Mohr collected 22 cases of extirpation of a cystic kidney, usually under the supposition that the tumor was malignant. In 7 cases the patient quickly died on account of the disease in the other kidney, although the organ was not palpable. In 15 cases the patient survived operation for at least a year. It is interesting to note that in one of these cases the urine before operation contained the maximal normal quantity of urea.

Nephrectomy for polycystic degeneration has not been so frequently performed in the last ten years. This is in harmony with the growth of a conservative sentiment in the treatment of renal troubles. The simple fact that cysts develop in a kidney is not sufficient reason for its removal; if there is also profuse hemorrhage, intense pain, suppuration of the cysts, or injury to neighboring organs by reason of the excessive growth of the kidney, extirpation may be indicated. Before it is carried out the functional capacity of the other kidney should be thoroughly studied.

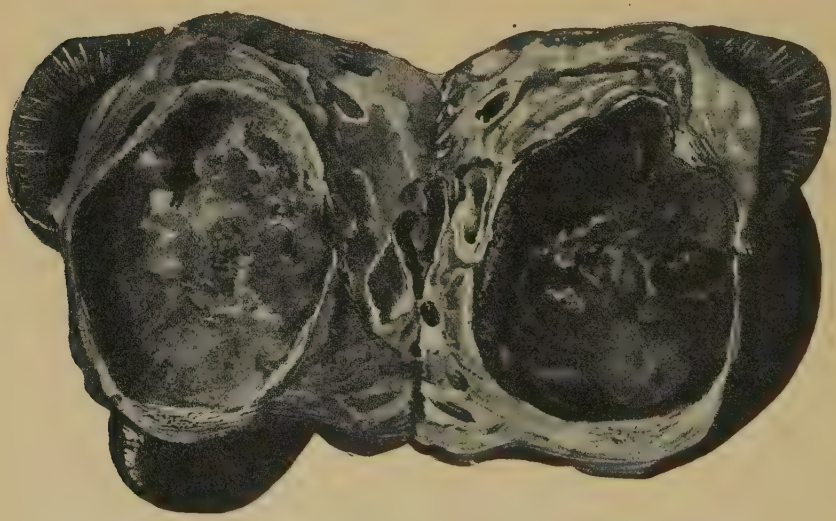
It must be recognized that the disease may develop unilaterally, or at least that it develops on one side to so slight a degree that the injurious effect of nephrectomy is totally wanting. Such a favorable result of operation is likely to be temporary, and the extension of the disease in the remaining kidney will probably soon terminate life. Thus Tändler removed the polycystic kidney of a man aged forty-four. Two months later there was a sudden attack of anuria. The kidney formed a tumor as large as a child's head. The diagnosis of renal strangulation was made and the kidney was exposed. It was found to be markedly cystic, and some of the cysts had obstructed the renal pelvis. The cysts were incised and rapid recovery followed, but there was slight prospect of a permanent cure.

Solitary Renal Cysts.—The formation of a so-called solitary renal cyst is by no means so dangerous a condition as the polycystic degeneration just described. This is a disease which is called by the French "Maladie kystique essentielle." These cysts are rare. Brackel counted only 21 cases recorded in medical literature from 1865 to 1899. The cysts are either single or exist in a limited number. They are found in one pole of the kidney, usually the lower one, or in the convex border. They arise in the cortex, for the smaller ones are completely surrounded by the cortical tissue; but they soon distend the free surface of the kidney, and may reach a very large size. One which was operated upon contained 2.5 litres of clear fluid stained brown with blood-pigment. The individuals affected have all been between the ages of eighteen and sixty-five years. If two or more cysts exist in a kidney, they may unite by destruction of the intervening tissue. These cysts are lined with a simple flat epithelium, or an epithelial lining may be wholly wanting. They are separated from the renal parenchyma by a layer of connective tissue. The contents vary in character. The fluid is usually clear and thin, possibly bloody, and sometimes of a cloudy character. It contains albumin and salts,

and occasionally traces of urea and possibly concretions of calcium oxalate, either free in the fluid or attached to the wall. Two-thirds of the reported cases occurred in women.

The origin of a solitary cyst is not clearly understood. Hence the writers consider that they are retention-cysts beginning in the glomeruli or tubules. It is supposed that desquamated and degenerated cells, favored perhaps by small hemorrhages, obstruct the exit of the capsule and lead to cystic distention; or that a colloid degeneration of the tubular epithelium obstructs the tubule. Other theories are that the cyst develops after a proliferation of epithelium in a manner similar to the polycystic adenocystoma; also that the cyst develops in the remains of the Wolffian body or one of Müller's ducts. As stated, there are no definite facts to support one or the other of these theories.

Fig. 131.



Teratoid bony cystic tumor of the kidney. The cyst surrounded by bony plates is shown between the remains of the upper and lower poles. The cavity was filled with masses of cholesterin. (Wyss.)

Treatment.—The treatment of a solitary cyst is better understood than its etiology. As the renal parenchyma is not affected except by the pressure, extirpation of the cyst with resection of as little as possible of the surrounding tissue should be followed by suture. This is the operation performed by Tuffier and others, while Ferrier advocates simple incision with suture of the sides of the cyst into the wound in the abdominal wall. Such a procedure may cure the patient, but will prolong the convalescence.

Cystic Teratoma.—In exceptional instances a cystic tumor of the kidney may contain other heterogenous tissue, such as bone. (Fig. 131.)

Paranephritic Cysts.—These tumors are rarer than the renal cysts already described. They occur for the most part in old age. They are

thin-walled tumors lined with smooth epithelial cells, and they may be situated either in front of or behind the kidney.

PRIMARY NEW GROWTHS OF THE RENAL PELVIS.

A primary tumor of the pelvis of the kidney is of rare occurrence. It may be of epithelial character, or it may develop from remains of embryonic connective tissue.

A papilloma is usually found in the bottom of the renal pelvis, from which place it grows toward the ureter. It closely resembles a papilloma of the bladder. Such a tumor is usually multiple.

An epithelioma of the pelvis of the kidney is generally of the alveolar type, more rarely of the cylindrical type. It soon affects the kidney and leads to lymphatic metastasis. It may obstruct or displace the ureter and produce uronephrosis, hæmatonephrosis or pyonephrosis.

A tumor of the renal pelvis of the connective-tissue type may either grow into this cavity and extend into the ureter, in which case the growth is apt to be polypoid; or it may grow outward. Albarran mentions the occurrence of rhabdomyoma, myxoma, angiosarcoma, and lymphatic endothelioma in this situation.

The symptoms of these new growths are those due to the presence of a tumor, hæmaturia, and pain. There may also be retention of urine with its natural consequences, such as attacks of pain and temporary swelling. The urine may contain portions of the new growth, or one may observe through the cystoscope that a papillomatous tumor protrudes from the urethra. If a papilloma is single, pedunculated, and benign, it may be excised. If many papillomata are present, or if the tumor is malignant, the kidney should be removed together with so much of the ureter as may be affected.

ANEURISMS OF THE RENAL ARTERIES.

As an aneurism of the renal artery may closely resemble a renal tumor, it is well to consider it at this point. This is, on the whole, a rare lesion. Keen collected records of only 13 cases published in the nineteenth century. Most of these aneurisms were small, not larger than a walnut. Some of them caused death by rupture into the pelvis of the kidney or into the peritoneum, or by embolism. In some instances the aneurism was discovered accidentally at autopsy. Surgical treatment might be of avail in the case of rupture of an aneurism into the renal pelvis. In the case of rupture into the peritoneum, the patient would probably be comatose before anything could be done. Keen reports a case occurring in a woman aged forty-five, in which the aneurism gave rise to repeated attacks of lumbar pain accompanied by vomiting, sometimes by fever. There was no jaundice, but a diagnosis of biliary colic was made. There was a moderate swelling in the loin. As the tumor increased in size the urine contained a little blood. Keen

operated upon this patient with success, removing the affected kidney. The aneurism was found to start from a branch of the renal artery, and had produced atrophy of the kidney through pressure. In 6 of the cases mentioned the aneurism followed traumatism. In 4 of these cases there was hæmaturia immediately after the traumatism, and which recurred at intervals. These aneurisms were the so-called false aneurisms. The tumor was often elastic, but in no case did it pulsate, nor was there any bruit to be heard over it.

The record of these cases shows that a small aneurism of the renal artery or one of the branches may exist for a long time without producing a symptom. It may lead to death by rupture into the peritoneum or into the retroperitoneal tissue. Rupture into the renal pelvis gives rise to hæmaturia, which may be fatal unless it is relieved by operation.

A traumatic aneurism is almost always accompanied with hæmaturia. This is, of course, a serious symptom, and if the hemorrhage is large, or is repeated, operation should be performed. If a tumor forms within a short time after such a traumatism, the suspicion of aneurism is a strong one.

No signs have as yet been discovered which enable a surgeon to say absolutely that an aneurism exists. The tumor is elastic, more or less tense, nearly though not quite movable, and sometimes indefinitely fluctuating. Pulsation and bruit are signs which have never been noted, probably on account of the relatively small artery as compared with the size of the aneurismal sac.

Treatment.—The only treatment is extirpation of the aneurismal sac, which, of course, implies removal of the kidney. The three patients operated upon by Albert, Hahn, and Keen all recovered.

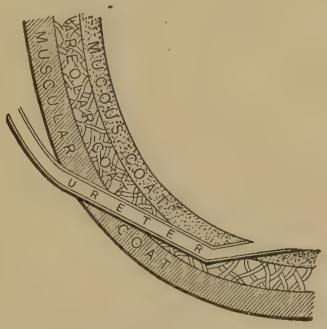
It is well to consider the possibility of an aneurism in case of hæmaturia of unknown origin, or occurring after traumatism, and in case of tumors in the region of the kidney which occur either with or without hæmaturia and the nature of which is in doubt. The results of operations hitherto performed are favorable to further attempts at a radical cure.

CHAPTER XVII.

INJURIES OF THE URETER.

Anatomy.—The ureter is a muscular and membranous tube which conveys the urine from the pelvis of the kidney to the bladder. Its upper end is not marked by a sharp line, since the contraction of the pelvis into the ureter is a gradual one. The termination of the ureter in the bladder is in the trigonum. The course of the ureter and its relations have been described on page 181. It enters the pelvis near the rectum, keeping close to this organ. It passes behind the peritoneum in front of the pyriform and internal obturator muscles, and over the levator ani. In man it follows the rectovesical fold to the bladder. In woman it enters the base of the broad ligament and passes along the cervix uteri forward and downward to the anterior wall of the vagina, to which it is closely attached for a distance of 1 or 1.5 cm. (0.4 or 0.6 inch). It then bends slightly toward the median line and enters the bladder. (Fig. 132.)

FIG. 132.



Showing the manner in which the ureter enters the bladder. (Gerrish.)

For convenience the ureter is divided into an abdominal part and a pelvic part. The abdominal part is again divided into an adrenal portion reaching to the lower pole of the kidney, and an infrarenal portion reaching to a point where the ureter crosses the common iliac artery or the external iliac artery. The pelvic part may again be divided into a parietal portion and a visceral portion. The average length of the right ureter is 29 cm. (11.6 inches), and that of the left 30 cm. (12 inches). Its calibre varies. In the adrenal portion its diameter is 6 mm. (0.2 inch), and gradually decreases in size to a point from 4 to 9 cm. (1.6 to 3.6 inches) from

the hilus, called the upper isthmus, where the ureter is contracted to a diameter of 2 to 3 mm. (0.1 inch or more). The infrarenal portion is fusiform, having a diameter varying from 8 to 15 mm. (0.3 to 0.6 inch). At the point where the ureter crosses the artery it is narrow (the lower isthmus), having a diameter of 4 mm. (0.2 inch). This is also the diameter of the pelvic portion.

The ureter is irregularly curved in both the frontal and sagittal planes, and it is bent at an oblique angle where it crosses the iliac vessel to enter the pelvis. There are two frontal bends, one in the abdominal portion with its convexity toward the median line, and one in the pelvic portion below the iliac vessels, with its convexity directed forward and outward. The sagittal curves are more marked and give the ureter the shape of a section through the lumbosacral vertebral column. In the abdominal part the ureter is slightly bent forward, as are the lumbar vertebræ. As the tube enters the pelvis it is bent sharply backward, corresponding to the angle made by the sacral vertebræ. Still further downward it is again bent forward and somewhat upward in order to reach the bladder.

In examining the ureter by palpation in order to determine the presence of a stone, or a dilatation, or a thickening, infiltration, etc., it is well to remember that the abdominal part of the tube corresponds to a perpendicular line drawn to the junction of the middle and inner thirds of Poupart's ligament. The innominate line crosses the ureter about 4.5 cm. (1.8 inches) from the median line. This point is at the crossing of a longitudinal line drawn through the spine of the pubes and a transverse line joining the two anterior superior iliac spines.

The visceral portion of the ureter can be palpated in man through the rectum. Guyon has called attention to the extreme sensitiveness of this region when a stone lies in any portion of the ureter. In women the ureter can be palpated to a distance of 5 to 8 cm. (2 to 3.2 inches) through the vagina, to which it is closely related.

Prognosis.—Accidental injuries of the ureter are not of common occurrence. Le Dentu found a record of only 20 cases in a period of ten years. The commonest cause of such an injury is the passage of the wheel of a vehicle across the body. As the injury is usually situated near the kidney, it is supposed that a forcible displacement of the kidney stretches the ureter over the transverse process of the first lumbar vertebra and thus tears or otherwise injures it. Sometimes the injury has first been recognized at autopsy. Sometimes a diagnosis has been made from such symptoms as a fluctuating tumor, escape of urine, perinephritis, and a favorable result following nephrectomy. In case of a slight injury not requiring surgical treatment the diagnosis may remain uncertain. Cystoscopic examination may serve to establish the diagnosis.

An injury of the ureter is usually revealed by the development

of a fluctuating tumor several days or weeks after the accident, the contents of which is shown by aspiration to contain urine, while the urine passed from the bladder contains little or no blood, and its quantity is much diminished from the time of the accident. If the ureter is torn clear across, no urine will pass from the corresponding kidney to the bladder. If it is partially torn, the urinary flow may continue to a greater or less extent, while if it is contused so that a portion of its wall subsequently necroses, there will be sooner or later a retroperitoneal extravasation of urine with more or less obstruction in the corresponding kidney.

A cure after rupture of the artery has been accomplished by repeated aspirations, but this method of treatment is not to be recommended at the present time. While it is true that the danger of urinary infiltration following injury of the ureter is not very great, still it does exist, and therefore the rational method of treatment is to expose the ureter through an incision to afford free drainage for extravasated urine. Direct surgical treatment of the ureter is doubtless possible if the incision is made soon after the accident, but so far as known this operation has never been performed.

The reports of cases show that the risk of renal infiltration is slight, partly because the lumen of the ureter is apt to be stopped by the swelling of the tissues and the presence of blood-clots, and partly because the injury acts in a reflex manner upon the kidney to reduce the urinary excretion. Sometimes this excretion is suspended altogether for a time. This reflex influence may extend to the other kidney, producing a marked oliguria. Such an oliguria is rapidly relieved by removal of the affected kidney. Various forms of treatment are therefore to be considered. (1) An early exposure of the ureter through an incision is indicated if there is a local swelling, or a marked diminution in the quantity of urine, or urinary retention in the renal pelvis. (2) If the symptoms are doubtful and not urgent, the surgeon should await developments. (3) An incision should be made retroperitoneally to expose the ureter and other injured tissues in case there is increasing extravasation of urine and blood, and especially so if suppuration is added. (4) If the ureter is injured beyond hope of repair, or if there is reflex anuria, nephrectomy should be performed. This operation is also indicated in some cases of fistula.

The ureter has been injured in a few instances by the point of a knife or other sharp instrument. If such an accident occurs, the wound should at once be enlarged and the injury treated in accordance with the principles mentioned above.

The ureter may be injured in difficult childbirth or by an ill-fitting pessary. In recent times it has often been injured by the extensive operations which are performed through the vagina. Such an injury is sometimes intentional, as in the case of the removal of an extensive carcinoma. Usually, however, it is accidental. Para-

metritic cicatrices and contractions due to carcinoma may so draw upon the ureter that it lies in intimate contact with the uterus and vaginal vault. Under such circumstances it is easily injured by clamps and ligatures. Vaginal operations of this character should therefore be avoided unless the parametritic tissues are free from contraction. Injury of the ureter occurring in this manner is situated almost invariably below the point where the ureter is crossed by the uterine artery. This point is about 1.5 cm. (0.6 inch) removed from the uterus, a distance which is slightly more on the right side than on the left. The portion of the ureter below this point of crossing measures about 4 cm. (1.6 inches). It is distant about 1 cm. (0.4 inch) from the external os uteri. This is the same portion of the ureter which may be injured in sacral operations upon the rectum, although if the rectal operation is extended well upward a higher portion of the ureter may also be injured. However, injury of the ureter occurs less frequently in operation for carcinoma of the rectum than in that for carcinoma of the uterus, for the reason that the lymphatic involvement in cancer of the cervix uteri lies close along the course of the ureter, while the lymphatic involvement in cancer of the rectum lies behind this organ in the median line.

In many instances fistula of the ureter following operation is a result not of direct injury, but of interference with the nutrition of the ureter, so that a portion of its wall becomes gangrenous. Under such circumstances the leakage will not occur for a week or more. If the defect is a small one, spontaneous cure may take place.

If the ureter is wounded, there will be an abundant discharge from the wound and a decreased amount of urine will be passed by the natural channels. But these facts are often overlooked in the days immediately following an operation, since at such a time the urinary excretion is often scanty and the discharge from the wound may be great. If a ureter is included in a ligature, there will be complete obstruction of the urine flowing from the corresponding kidney, a condition which will speedily make itself felt. Unfortunately, by the time this condition is recognized it is usually too late to correct the mistake. The most fortunate termination of injury of the ureter aside from spontaneous cure is the establishment of a fistula into the vagina or into the uterus. Operations to close these abnormal openings are technically difficult, but they have been many times successfully performed.

Simon was the first to describe a fistula between the ureter and vagina, but his attempt to close it failed. In 1876 Landau proposed to insert a slender rubber catheter into the ureter through the vaginal fistula, and to pass the other end of the instrument into the bladder and out through the urethra. His plan was then to close the ureter over the catheter. Although this might result in a temporary improvement, contraction of the narrowed ureter would be

almost certain to follow. Bandl improved this technic by allowing a portion of the vaginal mucous membrane to remain in connection with the ureteral opening. This plan was followed with success in 3 cases, but it did not altogether do away with the risk of contraction. Schede adopted another method by establishing a vesicovaginal fistula about 2 cm. (0.8 inch) in diameter, which was extended upward until it reached the ureteral fistula. The mucous membrane of the bladder and that of the vagina were then sutured together and the fistula was thus narrowed. Two weeks later when the wound had healed a catheter was inserted from the vagina into the ureter and also into the bladder and brought out through the urethra. A circle was then freshened around the fistula 1.2 cm. (0.5 inch) broad and separated everywhere from the fistula by an area of healthy mucous membrane 3 or 4 cm. (1.2 inches) in width. The wounded surfaces were then sewed together and the fistula was thus closed. By this method of operating the lower end of the ureter was first provided with a complete margin of healthy mucous membrane, and was next turned into the bladder. In Schede's case there was still some tendency toward cicatricial contraction which he was able to overcome by the passage of ureteral sounds.

Dührssen divided the septum between the ureter and bladder for a distance of about 1 cm. (0.4 inch), uniting the cut edges by suture, thus raising the point at which the ureter opened into the bladder. He then closed the fistula into the vagina by dissecting up a flap of mucous membrane and stitching it in position in the usual manner. A ureteral catheter was left in place for two days.

Mikulicz made a fistula from the vagina to the bladder and clamped the tissue between the bladder and ureter until it necrosed. The blade of the instrument which was passed into the ureter was made hollow to provide for the escape of urine. When a new ureteral opening into the bladder was established, the vesical fistula was closed.

Fritsch reported a case of vaginal fistula associated with prolapse of the anterior vaginal wall in which he was able to dissect the ureter free for a distance of 4 cm. (1.6 inches) and to implant it in a new situation in the bladder. The whole dissection was carried on outside of the vagina, and it was, therefore, not at all difficult. This method would not necessarily be suited to an ordinary case of ureterovaginal fistula.

By one or the other of these methods most fistulas of this character can be successfully closed. That described by Mikulicz is the most easy of performance, but time is required to show whether or not there is danger of including a loop of intestine in the clamps. Dührssen's method gives the widest opening of the ureter in the bladder. His idea that the turning of a small strip of vaginal mucous membrane into the bladder is likely to be followed by calculous formation has not been proved by experience.

The ureter may be injured in difficult laparotomies. This accident is less common under such circumstances than as a result of vaginal extirpation of the uterus, but is more common than injury of the ureter during extirpation of the rectum. Doubtless, a good many instances of this sort have been overlooked during life, and also at autopsy in cases in which the patient has died within a short time after operation. Indeed, the injury of the ureter may very well have been the cause of death under such circumstances. It is not surprising that the ureter should be injured during the removal of an adherent tumor from the pelvis when the operator has been compelled to use considerable force and to work deep in the pelvis without being able to see what tissues he is dividing. Hasty ligation of bloodvessels to stop free hemorrhage may also lead to inclusion of the ureter in the ligature.

In view of such accidents the best operators make it a rule to examine the ureters at the close of a difficult laparotomy in order to be sure that they have not been injured or ligated. Kelly goes so far as to advise making a longitudinal incision into the ureter in doubtful cases in order to pass a probe in both directions. If the ureter is found to be intact the incision may be sutured. The advantage of such caution is shown by the experience of Tuffier, who twice exposed such a ureteral wound and sutured it. These patients recovered. In four other instances in which this was not done, it was necessary to remove the kidney. Many other operators have reported similar accidents, some of them having saved their patients by early removal of a ligature which had accidentally been placed upon the ureter or by suture of a ureteral wound, or by removal of the corresponding kidney. But such operations are not always successful, and patients have died in spite of efforts to save them, while others have recovered with a urinary fistula. Blumenfeld reports an interesting condition found at autopsy. A ureter had been ligated accidentally with catgut, but the injury was apparently not a permanent one, since the ureter had not sloughed, and was pervious for a sound, as the ligature had gradually loosened under the pressure caused by the obstructed urine. Naturally it is better to prevent such an accident than repair it after it has occurred, so that Kelly's advice to introduce a ureteral probe before beginning extirpation of the carcinomatous uterus is well worth following. In the removal of pelvic tumors by laparotomy it is better to begin the dissection on the opposite side from the ureter most likely to be involved.

It is well known that a tumor of the ovary or a myoma of the uterus may displace one or both ureters. This may occur, according to Blumenfeld, in any one of the following ways: 1. A tumor may displace the uterus and bladder and thus drag the ureter of the same side with itself abnormally near the median line. 2. A tumor may in its growth attach itself to the uterus and the bladder and draw these organs with it in its further growth, thus bringing the oppo-

site ureter abnormally near the median line. 3. The tumor may in its growth attach itself to the ureter, and by its further growth displace it in any direction. This method of displacement is common with an intraligamentous myoma, but may also occur in connection with tumors of the ovary, especially papillary cystoma. While the tumor grows between the uterus and bladder it raises the bladder upward and thus comes into contact with the ureter, to which it attaches itself. In this manner the ureter is lifted forward and backward and will be found even as high as the umbilicus.

Treatment.—The treatment of an injury of the ureter occurring during an operation is founded upon the results obtained by experiments upon animals, and also upon the experience of different operators. If a ureter is cut longitudinally, either accidentally or for the removal of a calculus, a perfect recovery is easily obtained. If a calculus has lain in the ureter for some time, the tube will be dilated and its wall will be thickened. Both of these conditions are favorable to suture and an incision, since the wounded surfaces which are brought into contact by the suture are broader than they otherwise would be, and in some instances it is possible to turn in the edges with a sort of Lembert suture without narrowing the lumen to a dangerous degree. Even without suture most of these small ureteral wounds, whether longitudinal or oblique, will heal well and permanently.

If the ureter is cut across, the condition is not so favorable. Experiments made upon dogs by Tuffier show that the cut ends may fail to unite, and that sometimes when they unite a stricture results.

The earliest instance of suture of the divided ureter in man was recorded by Schopf in 1886. The ureter was divided during an ovariotomy. The ends were temporarily clamped, and at the close of the operation were freshened and brought together by eight silk stitches which did not penetrate the mucous membrane. By these stitches the wounded edges were slightly inverted. The wound healed primarily. As the patient died from tuberculosis seven weeks later, Schopf had an opportunity to examine the ureter. He found it imbedded in scar-tissue and much contracted. The renal pelvis was considerably dilated. He concluded that it is better to suture the ureter over a catheter which extends through the bladder and out of the urethra. The wound would thus be protected from urine and the lumen of the ureter preserved.

Fritsch considered such precautions unnecessary on account of the slight pressure which exists within the ureter. He united the severed ends with catgut stitches and obtained a perfect result.

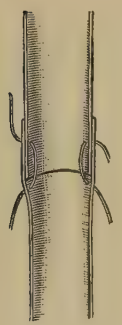
The methods as outlined by Schopf and Fritsch were followed by many other surgeons, some of whose patients recovered, while some of them died. In every instance, however, the condition of the ureter was satisfactory.

Bovée and Tietze cut the ends of the ureter obliquely before suturing them, so that the resulting scar should not be circular.

D'Antona invaginated the central into the peripheral portion of the ureter, a method which was also carried out with success by Poggi and Winslow. (Figs. 133 and 134.) The peripheral end is split up sufficiently to admit the central end, and the longitudinal cut is then closed over it with sutures and a few superficial sutures are inserted to fix further the two ends.

Monari performs a lateral anastomosis. (Fig. 135.)

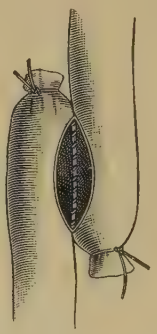
Fig. 133.



Poggi's method of repairing the ureter by invagination.

Fig. 134.

Fig. 135.



Monari's method of lateral anastomosis.

Van Hook inserts the central end into a lateral slit in the peripheral end. The peripheral end should be ligated, and the lateral incision which begins 0.6 cm. (0.3 inch) below the ligature should have a length equal to twice the diameter of the ureter. The central end of the ureter should be split up for 0.5 or 0.7 cm. (0.2 or 0.3 inch) in order to insure permanence of the opening. (Fig. 136.) Two needles are threaded with fine catgut and passed from within outward through the free end of the central portion of the ureter opposite to the longitudinal incision. The needles are passed through the lateral incision in the peripheral end, and out again through the wall of the ureter a little further down. By means of this catgut thread the central portion can be drawn into the peripheral and fixed there, by tying the suture. If the operation is carried out intraperitoneally, the ureteral wound should be covered with a flap of peritoneum.

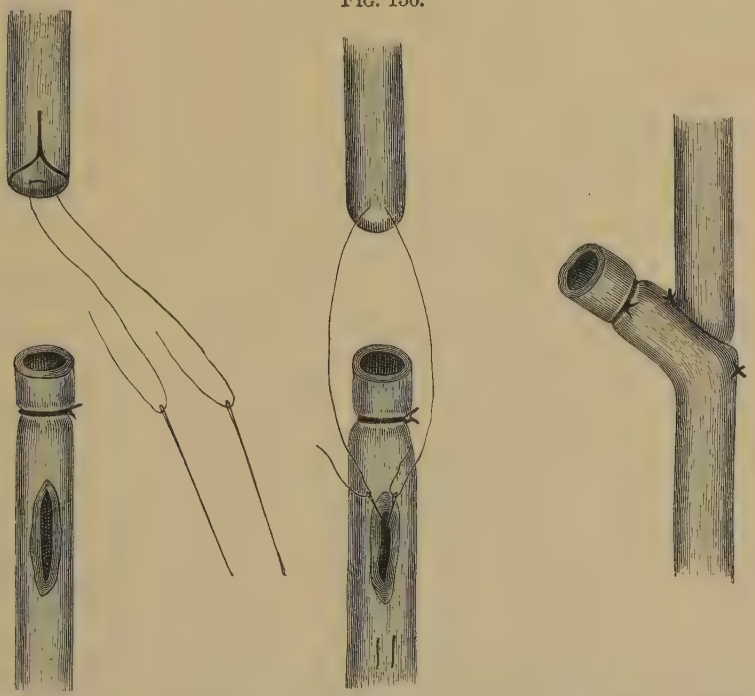
Experiments upon dogs have shown that this method of suture gives better results than any other, and the cases in which it has been employed in man tend to confirm this opinion. The healing is prompt, and there is no tendency to the formation of a stricture. If loss of substance prevents the application of this principle, an oblique circular suture should be employed in preference to a transverse one.

If the ureter is partially divided and the wound involves more than a third of its circumference, it is recommended that the division

be made complete, to be followed by an implantation. Or the principle of the Van Hook method may be followed by making from the transverse wound a longitudinal cut equal to twice the diameter of the ureter, rounding its corners and suturing the resulting wound transversely. If this is done, the lumen at the point of suture will be widened, not narrowed.

The methods thus far described presupposes a simple division of the ureter without the loss of any considerable portion of the tube. On account of the normal course of the ureter and its elasticity, it is possible to carry out a direct suture even though there is a loss of substance up to 8 cm. (3.2 inches) in length. If there is a greater loss than this, some other method of repair is necessary.

FIG. 136.



Lateral implantation of the renal portion of the ureter into the vesical portion. (Van Hook.)

A fact which greatly influences the success of operations upon the ureter is the possibility of isolating it for a considerable distance without destroying its nutrition. This is due to the presence within it of two small arteries which spring from the renal artery and accompany the ureter almost to the bladder. It is also supplied by branches of the internal spermatic, and, in its lowest portion, by branches of the vesicular arteries. All of these vessels lie in the perimuscular connective tissue of the ureter, which should therefore

be left in connection with the tube when the latter is isolated. Several writers have reported isolation of the ureter to the extent of 10 cm. (4 inches) or more without injurious effect.

Molinari found by experiments upon dogs that he could isolate 13 cm. (5.2 inches) without injury if the ureter was replaced in its normal position and covered with peritoneum. If it was wrapped about with sterile gauze, not more than 6 cm. (2.4 inches) would maintain its vitality after isolation. This excellent nutritive supply of the ureter makes possible the choice of several methods of operation when there is considerable loss of the ureter. The choice of method will depend in large measure upon the situation of such a loss.

If the defect is situated at the upper end, an attempt should be made to suture the peripheral stump into the pelvis of the kidney, provided it can be done without too great strain upon the sutures. Küster resected a stenosed portion measuring 3 cm. (1.2 inches) in length and sutured the peripheral stump into the renal pelvis, thus curing the patient of uronephrosis. This has already been spoken of in connection with uronephrosis. If the lower portion of the ureter is damaged, the most natural method of repair is to implant the central end into a higher portion of the bladder. By this means Novaro cured two patients of urinary fistulas in 1893. He placed the patient on a table with the pelvis elevated, made an incision in the median line, divided the peritoneum to the side of the bladder, sought and found the ureter, and implanted it in the bladder retroperitoneally. Bazy performed the same operation, implanting the ureter in a portion of the bladder covered with peritoneum, and then covered the ureter with a peritoneal flap. Monari split the peritoneum parallel to the ureter on either side so as to leave a flap 1.5 cm. (0.5 inch) broad attached to the ureter. He opened the bladder by a vertical incision, split the ureter on its under surface for a distance of 1 cm. (0.4 inch) and sutured it to the bladder in such a manner that the upper end of the cut in the ureter was united to the lower end of the vesical incision, and the lower, horizontal portion of the ureter was united to the upper end of the cut in the bladder. By means of a second row of sutures inserted in the muscular coat of the bladder and periureteral tissue, he was able to cover the area of implantation with the peritoneal flap which remained attached to the ureter.

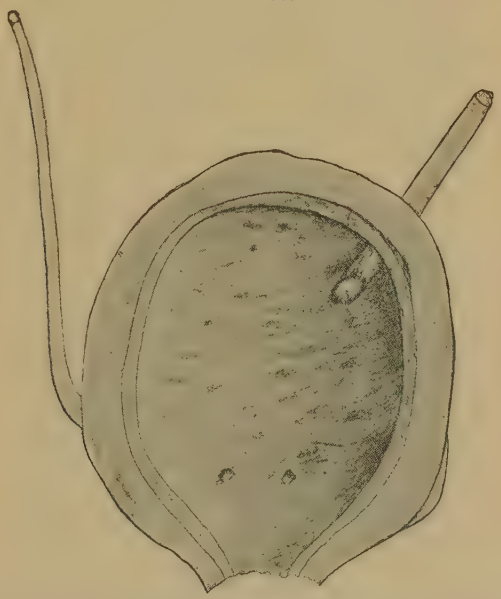
Veit freed the central end of the wounded ureter until he could close the peritoneum around it, and inserted its extremity extraperitoneally into the bladder.

Krause, after freeing the central end of the divided ureter, split it up a distance of 0.8 cm. (0.3 inch) anteriorly and posteriorly, and inserted in either half a silk thread which did not enter the lumen of the tube. The ureter was then implanted into the bladder, and the threads drawn out through the urethra and fastened in the

external orifice. The ureter was further fixed in place by catgut stitches through the serous and muscular coats. The end of the ureter projected about 1 cm. (0.4 inch) into the lumen of the bladder, since Krause had the idea that it would then form a sort of valve and prevent a back-flow of the urine when the bladder was distended. (Fig. 137.)

Witzel operated in the same manner, opening the peritoneum and exposing the ureter at the point where it crosses the iliac artery. It was again exposed in the level of the broad ligament, divided and freed as far as the iliac vessels. Its peripheral end was sutured and left in position. The central end of the ureter was then brought

FIG. 137.

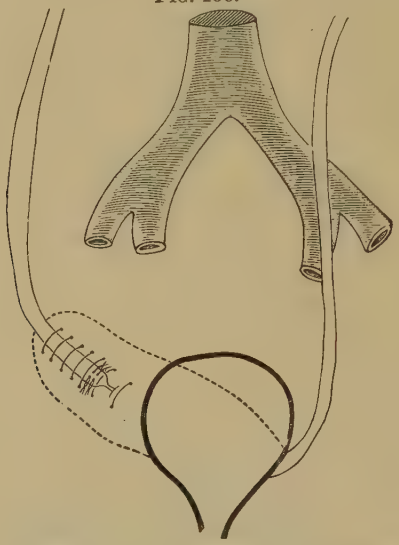


Resection of the left ureter and implantation of its stump in the bladder. (Krause.)

out of the incision in the peritoneum over the point where the iliac artery divides, and drawn down extraperitoneally for suture into the bladder. The openings in the peritoneum were the unsutured, and the bladder somewhat distended with boric acid solution. It was found that the bladder could be brought up far enough into the iliac fossa to permit suture without undue tension. It was therefore opened upon a catheter introduced through the urethra, the ureter was cut obliquely and inserted into the bladder and stitched fast with catgut sutures passing through the mucous membranes of ureter and bladder, and with a second row of stitches not penetrating the mucous membranes. Finally, the bladder-wall was stitched over the ureter so as to form an oblique canal—a step in the technic

similar to Witzel's gastrostomy. (Fig. 138.) The wound was drained through a counteropening and a catheter was left in position four days.

Fig. 138.



Extraperitoneal ureterocystostomy, with formation of an oblique canal by Witzel's method.

Fritsch freed the ureter for 5 cm. (2 inches) and cut it off. Next, the peritoneum near the bladder was dissected by the finger from the vesical and abdominal walls until a subperitoneal space was created. Into this the ureter was drawn through an incision into the peritoneum. The bladder was then brought up to meet the ureter and the implantation was effected extraperitoneally. The peripheral end of the ureter was not ligated or sutured. The patient made a prompt recovery.

These examples will suffice to show that the difficulties encountered can be overcome in a variety of ways according to circumstances, and that there is an abundant opportunity for the display of ingenuity in this field of surgery. In general, it may be said that an extraperitoneal implantation of the ureter into the bladder carries with it far less risk than an intraperitoneal one. Furthermore, a ureter which crosses the peritoneal cavity according to the methods of Krause and Viet offers opportunity for peritoneal adhesions and possibly intestinal obstruction—dangers which had better be avoided. Therefore the methods of Novaro, Witzel, and Fritsch are rather to be recommended, even though primary union is more likely to follow when the peritoneum covers the wound. The formation of an oblique canal similar to that in Witzel's gastrostomy is much to be recommended, since it most nearly imitates the natural condition and prevents a back-flow of urine from the bladder.

Ligation of the ureter does not always produce uronephrosis, so that in extreme cases the stump may be ligated and buried under the skin for safety.

FIG. 139.

Calculi impacted in a ureter, accompanied by uronephrosis. (Taylor.)

Implantation of the ureters in the rectum or sigmoid flexure, as performed by Simon and others, has thus far had only a limited success. An exception must be made for cases in which the whole

trigonum is implanted, as in Maydl's operation for extrophy of the bladder. In such cases an extraperitoneal implantation is practical. Otherwise implantation of the ureter is usually called for after removal of the bladder on account of carcinoma, or in case the central end of the divided ureter will not reach the bladder, and removal of the kidney is prohibited by the condition of the other kidney. The results obtained have been unsatisfactory. Both animals and man died within a short time from peritonitis, pyelonephritis, or uronephrosis, while those that survived the immediate effects of the operation died either from stricture of the end of the ureter implanted in the rectum, or from infection of the renal pelvis arising from the intestine.

CHAPTER XVIII.

DISEASES OF THE URETER.

Inflammation of the ureter, or ureteritis, is rarely seen as an independent disease. It usually occurs as a step in an inflammation which is extending from the bladder to the kidney, or in the reverse direction. The striking circumstance that the mucous membrane is only slightly if at all affected by this extension of the inflammation has led Albarran and Halle to the belief that such a transfer of infection takes place through the blood. Naturally this is possible, but when a ureter through which infected urine flows is only slightly irritated, one must admit that its tendency to inflame under such circumstances is slight. That this relative immunity does not always exist is shown by the condition of the ureter brought about by gonorrhœal or tubercular infection. The former inflammation not only quickly extends to the pelvis of the kidney, but it also produces serious changes in the mucous membrane of the ureter, and very likely of the whole ureteral wall, giving rise to the formation of valves, strictures, callous thickening, etc. Tuberculosis of the mucous membrane of the ureter produces chronic swelling, ulceration, and overgrowth of the submucous tissue, and changes the whole ureter into a stiff, inelastic tube with walls which in places are many times their normal thickness. Schede removed such a ureter and found its walls to be 1 cm. (0.4 inch) thick. It was also dilated on account of the stricture situated at its lower end, so that the tube was about as large as a man's thumb.

Isolated inflammation of the ureter, although a rare occurrence, is sometimes seen. In the nature of things, there is no reason why the mucous membrane of the ureter should not become inflamed just as well as the mucous membrane of a distinct section of the alimentary canal, or of the respiratory tract. Israel mentions such an instance in a man twenty-eight years old. Repeated attacks of pain in the ureter, associated with vesical tenesmus and occasional hæmaturia, seemed to point to the presence of a renal calculus. The kidney was exposed and incised, but it contained no stone. As the pains continued, the ureter was exposed and found to be pervious, but extremely hard and much thicker than normal. It was removed, together with the kidney, and the patient was freed from his symptoms. Microscopical examination of this ureter showed that its mucous membrane was in large measure irritated, while its muscular coat was much thickened and its muscular fibres

were everywhere separated by a great increase of connective tissue which must have interfered greatly with its function. The attacks of renal colic and almost constant pain were presumably due to the inability of the ureter to force the urine into the bladder by its normal peristaltic action. The urine would therefore collect until the elasticity of the kidney forced it into the bladder.

Stein describes a membranous form of ureteritis. This disease is marked by high fever, the appearance of pus and fibrinous clots in the urine, a strong feeling of pressure in the lumbar region and along the ureter without demonstrable swelling. He exposed the kidney and found it bluish-red, firmer than normal, and free from calculus. The ureter was dilated to the size of a thumb. He made an incision into it and withdrew a cylindrical clot which contained a great many colonies of staphylococcus aureus. A fistula followed this operation, but closed spontaneously in a short time.

Suppurative periureteritis is analogous to suppurative perinephritis. That is to say, an abscess forms around the ureter, accompanied sometimes with a rupture of the ureter and due probably to calculus. Snyers described a case as follows: A man aged nineteen, previously well, was taken suddenly ill with tenesmus and hæmaturia. The urine contained uric acid crystals, blood-casts, and red blood-cells. Examination of the bladder and kidney gave only a negative result. Four days later there were intense pain in the right iliac fossa, meteorism, anuria for twenty-four hours, and fever. Later an abscess was evident in the space of Retzius. An incision was made and a great quantity of pus and urine was evacuated. The abscess cavity entered the bladder and extended up and around the ureter. Some urine came from the wound for six days, while the urine which was passed from the bladder was perfectly clear. The patient recovered.

There is also a chronic proliferative ureteritis marked by the formation of connective tissue to such an extent that the ureter may be completely destroyed, which, of course, produces uronephrosis. This affection has been ascribed to gonorrhœa, but without sufficient proof.

The interest at present felt in the ureter is of recent date, and it is probable that our knowledge of its diseases will be greatly added to within a short time. One process which is better known than those above mentioned is ureteritis cystica, or chronic polypoid ureteritis. This is a disease of the ureter first described by Morgagni. Litten mentions a case in which for a distance of 13 cm. (5.2 inches) the ureter was so studded with cysts that normal mucous membrane could nowhere be seen. In other cases both ureters and the trigonum of the bladder have been affected. These cysts are surrounded by connective tissue and are covered on their free surface by a single layer of pavement epithelium. They contain mucus, red and white blood-cells, flat epithelial cells, and large "foot" cells, which are

constantly found in the deeper layers of the mucous membrane of the ureter, stratified masses and clumps of colloid degenerated epithelium, and structures similar to giant cells. Litten was unable to determine whether these cystic dilatations represented crypts which had been closed by mucous membrane, or whether they developed from glands.

Marckwaldt examined 700 cadavers in order to determine the frequency of this affection, and found it present to a greater or less degree in 62 of them. He states that the mucous membrane of the ureter has five or six layers of large cylindrical cells. He often found between the normal cells others which exhibited the processes of degeneration. These cells were sometimes near the surface, sometimes in the deeper layers. Sometimes they were grouped together. Another peculiarity of the epithelium of the ureter is the epithelial nests described by Brun. These are projections of epithelium having the appearance of a berry, although not divided to a very great extent. They may be either solid or hollow, and if hollow the lumen communicates with that of the ureter. On account of the frequency with which these epithelial nests are found, they have been considered normal structures. They may be found in any portion of the ureter, and exist at birth; but they are present in far greater numbers in older persons. The central portions of these epithelial nests show a tendency to degeneration, hence their change from a solid to a cystic condition. These cysts may grow to the size of a pea. As they do so, they project more and more into the ureter and finally burst and discharge their contents. Marckwaldt never observed inflammation in connection with them. In the course of his examinations he found well-developed ureteritis cystica 4 times; well-developed epithelial nests with few cysts once, and a moderate development of cysts 57 times.

If the disease is well developed, there will be many ragged edges of the ruptured cyst floating in the lumen of the ureter. The serous coat is invariably thickened, so that the ureter may have the diameter of a man's thumb. The ureteral wall is stiff, its lumen much dilated, and its opening into the bladder constantly wide open. In one instance it was possible to pass the little finger from the bladder into the ureter. The pelvis of the kidney may be dilated. Sometimes this disease appears to be congenital. It may spread to the bladder, and the accumulation of cysts may interfere with the action of the ureter. Such a child will be troubled with incontinence of urine, contraction of the bladder, and marked thickening of its serous coat, while the ureter stands wide open. In one case pregnancy interrupted the previously undisturbed flow of urine, leading to an infection which rapidly spread to the kidney and caused renal abscess and death.

The ureter may be the seat of tumors which in most instances will be secondary to tumors of the kidney. A small number of

primary tumors have been mentioned, most of them being of a papillomatous type. Such a tumor closely resembles the papilloma of the bladder, and may occur singly or in groups. It may extend to the renal pelvis, it may become carcinomatous, it may so obstruct the urine as to cause uronephrosis, etc. Sarcoma of the ureter has been mentioned.

The ureter is sometimes misplaced. Thus it has been found in the sac of an inguinal hernia. In another case, that of an infant two weeks old, a tumor of the ureter near the bladder produced retention, constant screaming, and vesical tenesmus to such an extent that the affected portion of the bladder containing the urethral opening prolapsed through the urethra.

Unfortunately there is not much to say in regard to the diagnosis of diseases of the ureter. One may learn from the cases above cited what the symptoms have sometimes been. Every ureteritis is secondary to inflammation above or below. It is impossible to tell from the character of the epithelial cells found in the urine whether the desquamation has taken place from the pelvis of the kidney or from the ureter. Both are covered with pavement epithelium, and the cells with so-called "tails" which were formerly supposed to come from the renal pelvis are now known to come also from the bladder.

In acute inflammation the ureter is very tender, while in chronic inflammation it is thickened. These two conditions can be recognized in men by digital examination through the rectum, and in women through the vagina. Furthermore, marked alterations in the ureter can be recognized by abdominal palpation in individuals who are not too stout.

In many cases the disease of the ureter itself is less important than the changes which it may produce in the kidney. For, not only may the inflammation extend to the kidney, but obstruction to the regular flow of urine may arise in the ureter. Therefore every inflammatory process of the ureter which may lead to a narrowing of its lumen, or to the formation of a valve, or a stricture, or kink, is of the greatest clinical interest, since it may be the starting-point of a uronephrosis.

CHAPTER XIX.

OPERATIONS ON THE KIDNEY AND URETER.

As the anterior surface of the kidney is covered with peritoneum, and as the kidney in its pathological state often contains infectious material, it is better to avoid the risk of peritonitis by operating upon the kidney and ureter from behind, making the incision in the lumbar region. An exception to this rule must sometimes be made if the position of the kidney is an abnormal one, or if a tumor of the kidney is of such size that it can best be attacked from in front transperitoneally. An exception must also be made in those cases in which the diagnosis is uncertain. Owing to the modern methods of investigation, this class is constantly becoming smaller. The operations which may be performed upon the kidney through a lumbar incision are :

1. The opening of a perinephritic abscess.

2. The evacuation of the blood or urine which has collected about the kidney as the result of traumatism, as well as the control of hemorrhage in this situation by ligature or gauze packing.

3. The exposure of a movable kidney for the sake of fixing it in position (nephropexy).

4. Simple incision of a fibrous degenerated and contracted capsule for the sake of relieving renal pain (nephroliberation as performed by Le Dentu, Folet, and Lambert).

5. Nephrotomy and pyelotomy—that is, incision into the kidney or the pelvis of the kidney for abscess and calculus, for uronephrosis and pyonephrosis, for echinococcus and solitary cysts, as well as simply for diagnostic purposes.

6. Resection of a portion of the kidney for diagnostic or therapeutic reasons.

7. Nephrectomy, or extirpation of the kidney on account of an extensive traumatism, or suppuration, or calculus, or uronephrosis, or pyonephrosis, or fistula of the ureter, or tuberculosis, or malignant tumor.

8. Exposure of the ureter.

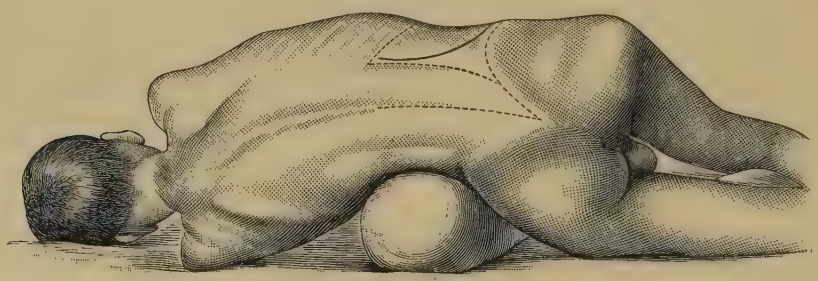
Complete removal of the kidney is naturally the most serious attack which can be made upon the organ. In performing this operation, therefore, one has to take all the various steps, some of which are essential to the other operations mentioned : hence it will save time and space to describe first in detail the technic of nephrectomy. In describing the other operations it will simply be neces-

sary to state at which point in the technic of nephrectomy the surgeon turns aside to complete the other operations. Some of these operations are spoken of in the sections devoted to the diseases which render them necessary, while in this chapter nephrectomy, nephrotomy, and resection and exposure of the ureter will be described in detail.

TECHNIC OF NEPHRECTOMY.

Lumbar Method.—The patient lies upon his sound side, turned slightly toward his face. A thick roll is pushed under him, between the costal margin and the crest of the ilium. This arches the loin to be operated upon, and thus facilitates the operation. (Fig. 140.)

Fig. 140.

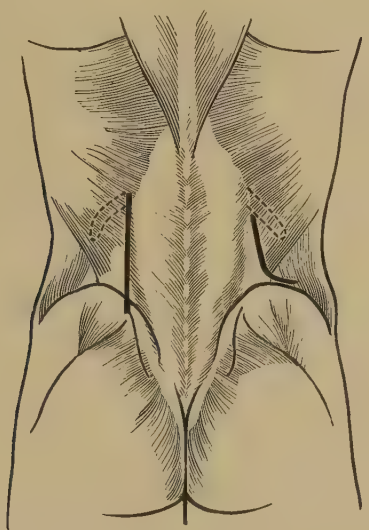


Position of patient for lumbar nephrectomy.

1. The original lumbar incision of Simon begins below the eleventh rib and extends downward 9–10 cm. (3.6–4 inches) along the anterior border of the sacrolumbalis muscle. (Fig. 141.) The edge of this muscle is felt with difficulty in very stout persons. It is situated 6.5–7 cm. (2.6–2.8 inches) from the spinous processes. As the incision is made deeper the subcutaneous fat is divided, then the superficial fascia and the latissimus dorsi muscle, which in this situation has a thickness of 0.25–0.3 cm. (0.10–0.12 inch). The firm fascial sheath of the sacrolumbalis muscle is then exposed. This is divided and the rounded border of the muscle laid bare, and search made in the upper angle of the wound for the twelfth rib. The next step in the operation is division of the posterior fascia of the muscle and ligation of the twelfth intercostal and first lumbar arteries as they cross the wound to enter the quadratus lumborum muscle near its insertion in the twelfth rib. Pansch states that the pleura may sometimes extend down to the level of the first lumbar vertebra, and the deep fascia ought therefore to be divided with caution. The quadratus lumbar muscle, which is next to be divided longitudinally, is about 0.5 cm. (0.2 inch) thick. It is covered anteriorly by the very thin transversalis fascia, which is the continuation of the fibrous layer of the peritoneum. Division of this fascia exposes the fatty capsule of the kidney, which is also divided.

The next step, the separation of the kidney from its surroundings, is the most difficult part of the operation. This dissection is made with the second and third fingers. At the upper and lower poles there will usually be found some fibrous bands which contain fair-sized arteries. These should be divided with scissors between ligatures. An aneurism-needle is often of great assistance in ligating these vessels. If strong fibrous bands are found at other points, they should also be ligated and divided. When this has been done, the kidney can be elevated from its bed and brought out of the wound so far that the hilus can be inspected. No great force should be used in this manœuvre.

Fig. 141.



Incisions for lumbar nephrectomy: left, Simon's; right, Guyon's.

If the kidney is to be extirpated, the next step in the operation is ligation of all the vessels of the hilus and their division close to the kidney. This is more easily done if the fat is first stripped away in order that the vessels and ureter may come plainly into view for separate ligation. The ureter lies farthest back, the artery next, and the vein farthest forward.

The advantage of Simon's incision is the slight injury it causes. It gives very little room, and is therefore ill adapted to the work to be done in many cases. Through this incision one can easily remove a healthy kidney, but gross pathological changes in the kidney, such as tumors, suppuration, firm adhesions between the kidney and its fatty capsule or the neighboring tissues, make it difficult or impossible to operate successfully through this incision. If one attempts to complete the operation under such circumstances,

the additional delay thus caused, the increased bleeding, and the difficulty of keeping the wound clean, will add greatly to the risk for the patient. In view of these facts, Simon, who first removed the kidney in 1869 through a lumbar incision, had few followers in his method, some surgeons preferring to accept the greater risk of the transperitoneal method. About 1879 the transverse and oblique incisions began to be employed, and since that time have been carefully worked out in all their details. It is unnecessary to state the various modifications which have at times been recommended; let it suffice to give the technic which is to-day generally considered to be the best.

2. The oblique incision begins over the anterior border of the sacrolumbalis muscle, about 1 cm. (0.4 inch) below the margin of the twelfth rib, and extends forward parallel to the line of the rib; or, in the case of tumors, more obliquely downward. Its length is determined by the necessities of the case. Many times the incision is sufficient if it reaches the anterior axillary line. The muscles and fascia are carefully divided until the retroperitoneal connective tissue is exposed. If the space thus gained is not sufficient, the incision is simply continued forward and downward without injuring the peritoneum. In this manner a wound may be obtained great enough to permit removal of the largest tumors. The only hindrance is above and backward, where the ribs may interfere with the dissection so as to prolong that part of the operation unpleasantly. On this account resection of the lower rib, or ribs, has sometimes been advocated.

The removal of a portion of the twelfth and eleventh ribs (Schmidt sometimes includes the tenth) makes easy of access the upper pole of the kidney and under surface of the diaphragm. This step must be taken with great caution on account of the close relations of the pleura to the parts about the kidney, as described in the chapter on the anatomy of this region. But one ought not, on account of the risk, to say that the ribs should never be resected. Schede has frequently resected the twelfth rib, and has never opened the pleural cavity; nor has there ever been evidence subsequent to operation that the pleural cavity was in any way damaged in his operations. Indeed, if one proceeds carefully, the wounding of the pleura is easily avoided; or, should a small opening be produced, it can be occluded by gauze until the operation is finished, and then sutured. Such a small opening is by no means so dangerous as some surgeons believe. It is not to be compared to the risk caused by a difficult dissection to free the upper pole of the kidney. Guyon gains space by extending the lower end of Simon's incision. (Fig. 141.)

3. Péan recommends a transverse incision. (Fig. 142.) This begins at the level of the umbilicus at the outer edge of the rectus muscle, and extends to the border of the sacrolumbalis muscle, which may even be divided for a short distance if necessary. If the tumor

is a large one, Péan advises a free opening of the peritoneal cavity in order to simplify the operation and to insure the complete removal of the new growth.

4. D'Antona and Bergmann, in 1885, recommended an incision which has been called the oblique lateral incision. (Fig. 143.) It begins at the upper margin of the twelfth rib, where the prominent border of the sacrolumbalis muscle is plainly to be felt through the latissimus dorsi. From this point it extends obliquely downward and forward to the junction of the outer and middle third of Poupart's

Fig. 142.

Péan's horizontal incision.

Fig. 143.

Bergmann's oblique incision.

ligament. The upper part of this incision is so placed that the tendinous portion of the external oblique lies in front of and beneath it, while the muscular portion lies behind and above it. The division of the various muscular layers is made from the upper end of the incision downward. The external oblique must be divided throughout the length of the wound, and afterward in the upper portion of the wound the internal oblique and the transversalis muscle. Still deeper will be found the yellowish transverse fascia. Under this is placed the layer of properitoneal fat, which varies in thickness in different individuals. The transverse fascia is to be divided between two thumb-forceps or on a grooved director throughout the whole extent of the wound.

5. König makes a retroperitoneal abdominal incision which begins at the twelfth rib, extends downward along the margin of the sacrolumbalis muscle, and just before it reaches the thick crest it bends

sharply outward toward the umbilicus and extends to the outer margin of the rectus muscle. (Fig. 144.)

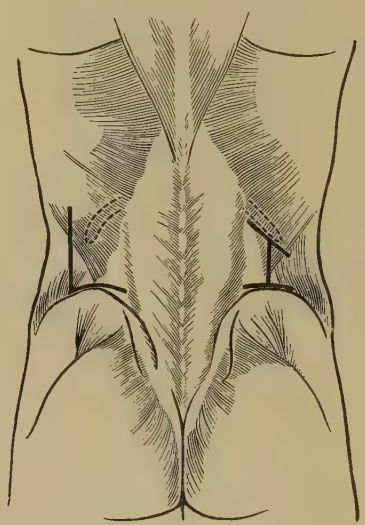
6. Bardenheuer makes an incision from the lower border of the eleventh rib to the middle of the crest of the ilium. A horizontal incision joins this perpendicular one, placed either above the crest of the ilium or along the margin of the ribs, according to circumstances. (Fig. 145.)

There are numerous modifications and combinations of the various incisions mentioned which it is unnecessary to specify in detail. Every surgeon will occasionally need to vary the direction of the incision to meet the conditions before him.

Fig. 144.

König's incision.

Fig. 145.



Bardenheuer's incision.

Bergmann's incision is especially to be recommended if there is before the operation a suspicion that the ureter may need to be explored. It should, however, be remembered that these very long incisions do not heal so perfectly as the shorter ones.

The peritoneum of the ascending or descending colon requires particular attention. Those affections of the kidney which greatly increase the size of the organ gradually push the peritoneum toward the median line. The same influence may also displace the ascending or descending colon. In the case of very large renal tumors this displacement of the peritoneum may be so pronounced that it does not extend further to the side than the outer border of the rectus muscle, or perhaps even not so far as this. The distention of the colon with air is a great help in showing the relation of the kidney to the peritoneum.

This displacement of the peritoneum does not add to the difficulty of the operation, and since it can usually be dissected bluntly from the underlying kidney or tumor, it is often possible to extend the incision nearly to the median line without opening the peritoneal cavity. If the affection is of an inflammatory nature and has lasted a long time, the adhesions and new-formed fibrous tissue may be so strong that it is no longer possible to separate the peritoneum from the kidney. A malignant tumor may also reach a stage of development in which it involves not only the fatty capsule, but also grows through into the peritoneal cavity. Under such circumstances the affected portion of peritoneum must be removed if it is possible to do so without opening the colon.

The danger which follows opening the peritoneal cavity is due chiefly to the fact that it may pass unobserved, and that infectious material may find its way into it from the kidney. In order to avoid this, accidental openings should be sutured at once. The same plan of action should be applied to openings accidentally made into the intestine.

The value of a lumbar incision is due not so much to the fact that the peritoneal cavity is not opened by it, as to the fact that it is less exposed to infection. Accidental opening of the peritoneal cavity is not serious if it is properly treated. Thus, if the peritoneum is closely attached to a tumor, it has frequently been recommended to open widely the peritoneal cavity in order to facilitate removal of the tumor and so much of the peritoneum as may be affected. This is especially to be recommended if it can be done without risk of infection. It is a procedure which saves much time.

Kocher makes a practice of incising the peritoneum sufficiently to permit him to insert his hand in order to palpate the other kidney. As soon as the hand is withdrawn, the peritoneal wound is sutured and the operation continued in the usual manner.

Large tumors often have a very extensive blood-supply. A careless wounding of these vessels adds seriously to the risk of the operation. They should therefore be divided between ligatures or artery-forceps. While one assistant holds the edges of the wound and the border of the ribs well out of the way with sharp or blunt hooks, another should press the tumor from the abdomen into the wound. The surgeon will then be able to separate it easily step by step. Above all things, he should see what tissue he is cutting. Unfortunately, there are times in which this rule cannot be followed; for example, it is impossible to see the upper pole of the kidney before its removal. This dissection must be carried out in the dark by the sense of touch. Hence it is desirable to leave this step in the operation until the kidney has been elsewhere freed, so that it can be quickly brought forward and any hemorrhage checked at once.

In bringing the kidney out it should be well in hand, so that no

sudden sharp strain shall be brought upon the vessels. There are instances in which fatal hemorrhage has followed too violent extraction of the organ.

Sometimes it is impossible to ligate the vessels of the hilus before the kidney has been removed, either because they are surrounded by scar-tissue and cannot be recognized, or because they are so involved in the growth that they have become too short for such ligation. A good way to meet this difficulty is to pass an elastic ligature around the hilus and then to cut away the major portion of the tumor of the kidney, leaving a small stump close to the ligature. With the additional room thus gained, the surgeon may be able properly to ligate the vessels and remove the remaining portions of the tumor. If the nature of the disease warrants it, the elastic ligature may be left in place, or specially constructed clamps may be used to control the hemorrhage. These may also be left in place.

There are even more difficult cases in which ligation of the renal vessels is absolutely impossible. Schede cites a case in which the veins were so involved in the tumor that an elastic ligature included a portion of the vena cava. This made it necessary to resect a little bit of the wall of the vena cava and to close the wound, 2 cm. (0.8 inch) in length, by a fine catgut suture. This suture of the vein did not interrupt the circulation through the vein, and the patient recovered.

In most cases of extirpation of the kidney, the separation of the organ should be carried out between the fatty capsule and the fibrous capsule. But this rule has many exceptions. If the affection of the kidney is of a tuberculous or of a malignant character, it is desirable to remove with the kidney as much of the fatty capsule as possible, in order to render recurrence less likely. If the fatty capsule cannot be removed with the kidney, it may be removed bit by bit after the kidney has been extirpated. This step in the operation has been compared to removal of the axillary fat in a complete operation for mammary carcinoma. There are chronic inflammatory conditions of the kidney in which the fatty capsule has been involved, and has gradually been changed into scar-tissue, the fat disappearing at the same time. The adhesions with the surrounding parts may then be so extensive that it is impossible to separate the kidney by dissection outside of the fibrous capsule. It may therefore be desirable to shell the kidney out of its capsule after the large vessels have been ligated. For this purpose either the fingers or a sharp spoon may be employed. This method of nephrectomy has also been recommended in traumatic cases in which the kidney is badly crushed, and in which the chief arteries cannot be readily reached for ligation. It is a much quicker procedure than the dissection of the kidney between the fibrous and the fatty capsule. The hemorrhage under such circumstances may not be very great, even though the chief vessels have not been previously ligated.

Tuffier removes the kidney piecemeal, leaving the fibrous capsule in place. This operation is called "morcellement," and is recommended by him for those cases in which the kidney is intimately adherent to its surroundings, and for those cases in which on account of the sclerotic changes in the parenchyma of the kidney the bleeding is insignificant, and also for the cases of nephrectomy secondary to nephrotomy. In the last-mentioned instance he advises that the new incision should be made not through the old scar, but to one side of it. The various steps are as follows:

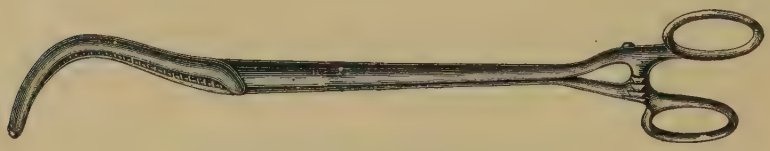
FIG. 146.

Renal morcellement. Removal of lower pole, and partial or total clamping of the vessels of the hilus. (Tuffier.)

An incision parallel to the twelfth rib exposes the kidney in the usual manner. Then follow splitting of the capsule and decortication of the lower pole. This pole is clamped with a strong instrument and removed. (Fig. 146, *k*.) The hilus is compressed with a sharply curved clamp (Fig. 147), an act which is facilitated by removal of the lower pole. The separation of the kidney from its fibrous capsule is continued until it is possible to clamp it above the hilus. This step is followed by division of the kidney above the clamp, curved scissors being employed. (Fig. 148, k^2.) Through the gap thus caused a long-curved clamp is applied to

the remaining vessels of the hilus. (Fig. 148, k^3.) The upper pole of the kidney does not usually bleed, and may be neglected until the middle third of the organ has been removed. The

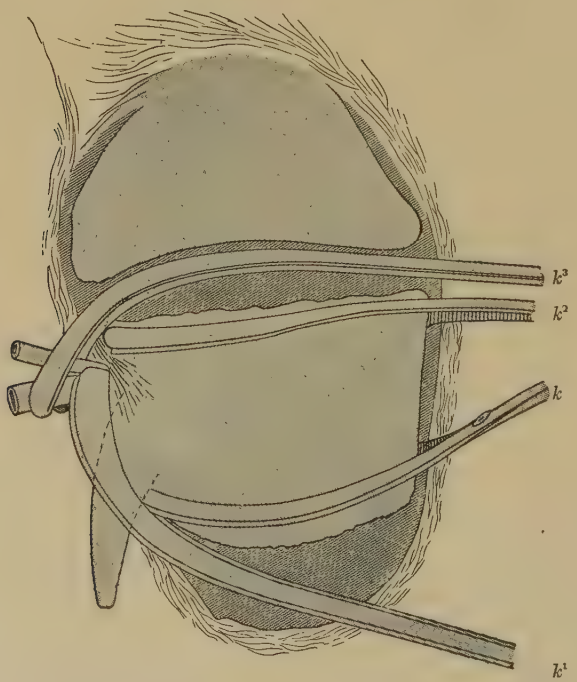
FIG. 147.



Curved clamp for seizing the renal pedicle.

clamps (k and k^2, Fig. 148) are superfluous and are taken off, and the middle third of the organ is cut away piecemeal until only a small stump remains. (Fig. 149, *St.*) The upper third of the kidney can then be extirpated without difficulty. These fragments

FIG. 148.



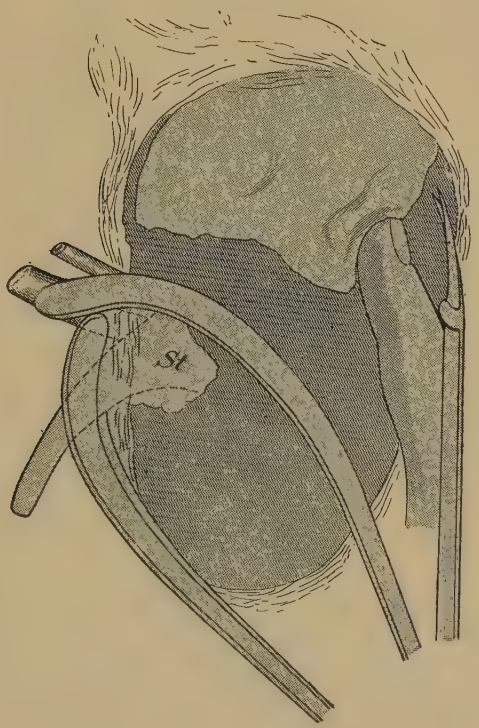
Renal morcellement. Removal of central portion. (Tuffier.)

when put together for removal will present the appearance shown in Fig. 150. The vessels of the stump are ligated and the clamps removed. When this is difficult, the clamps may be left in position. The ureter is usually ligated and left in the wound. If the ureter

is much inflamed and dilated as a result of stricture or compression further down, it is best to stitch it in the lower angle of the wound in order to avoid retention. If the ureter is tuberculous it should be removed, or fixed in the wound in such a manner that it can be locally treated.

Transperitoneal Method.—If the kidney to be removed is exposed by the transperitoneal method, the surgeon is able in a short space of time to examine all the relations of the kidney as well as to inspect the other kidney. This method of operating exposes the

FIG. 149.



Renal morcellement. Removal of upper third. (Tuffier.)

patient to a certain amount of risk on account of the handling, tearing, and pressure upon the other abdominal viscera. In many instances the danger of infection is very great, because it is frequently impossible to avoid tearing into the parenchyma of the diseased kidney, and pus may escape and infect the wound or peritoneum. An additional disadvantage of this method is the fact that a large retroperitoneal cavity is left which is not easily treated. A simple suture of the peritoneum and the posterior abdominal wall as recommended by many surgeons is not without risk, since blood and serum may

collect retroperitoneally. Such a cavity may be drained externally by a second incision, or else it may be tamponed through the abdominal wound. Schede recommends the latter procedure as being the safest treatment, and he carries it out by suturing together the anterior and posterior layers of the peritoneum. In this manner the peritoneal cavity is closed, while the retroperitoneal wound is easily accessible. A partition is thus formed in the peritoneal cavity, which later may be dissected out. (Heidenhain.)

Fig. 150.

Renal morcellement. The pieces of the kidney. (Tuffier.)

This same principle may be applied in order to reduce the risk of opening renal cysts. An abdominal incision is made and the anterior and posterior layers of the peritoneum stitched together or tamponed. Later the cysts can be opened without opening again the peritoneal cavity. Schmieden, by an exhaustive search though medical literature, found that 1118 nephrectomies had been reported, with a mortality of 29.6 per cent.; 554 of these were performed within ten years of the date of his search. Their mortality was only 17.4 per cent. as compared to 34 per cent. and 80.6 per cent. of the operations performed in the preceding decades. This is, of course, an encouraging showing.

Taking the whole number of nephrectomies and dividing them according to the method of operation the results are as follows:

Lumbar method 722 times, 557 recoveries, 165 deaths = 22.9 per cent. mortality.
Abdominal " 365 " 234 " 131 " = 35.9 " "

The mortality of the nephrectomies performed in the last decade is as follows:

Lumbar method 365 times, with 62 deaths = 17 per cent. mortality.
Abdominal " 165 " " 32 " = 19.4 " "

The causes of death were as follows:

	Lumbar.	Abdominal.	Total.
Disease of the other kidney, anuria, uræmia	45	11	56
Collapse—shock	42	49	91
Death during operation	1	1	2
Exhaustion, suppuration (amyloid)	8	5	13
Peritonitis	3	27	30
Sepsis, pyæmia	11	4	15
Hemorrhage, and secondary hemorrhage	2	6	8
Rapid extension of the disease	11	2	13
Absence or congenital atrophy of the other kidney	3	4	7
Intercurrent disease	19	9	28
Unknown causes			38
			301

In comparing the advantages and disadvantages of the lumbar and abdominal methods of operation it must be said in favor of the abdominal that it affords the surgeon in complicated cases a better view of the difficulties. The disadvantage is not so great as it might appear. Schede has removed the largest tumors through the lumbar incision, and so skilful an operator upon the kidney as Israel spurns the abdominal operation altogether.

Perthes thinks that the lumbar method does not permit dissection of infected glands in the neighborhood of the vena cava, but this opinion is not shared by all surgeons.

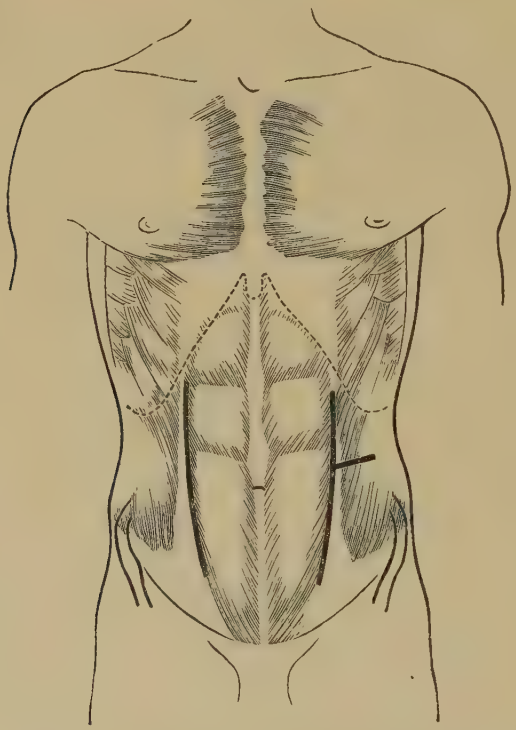
Trendelenburg gives the rule to operate upon all large tumors by the abdominal method, and upon all infectious troubles by the lumbar method. If this principle were universally adopted, the results of abdominal nephrectomy would be better than those of the lumbar operation. Schede is still of the opinion that the lumbar method is quite satisfactory in almost all conditions.

The incision employed in the transperitoneal method may be the usual one for laparotomy in the median line, or an incision may be made along the outer border of the rectus muscle. (Fig. 151.) The former incision is too far removed from the base of the tumor, while the latter does not give space enough except for small tumors. Trendelenburg therefore makes an oblique incision from the costal margin in the anterior axillary line to the spine of the pubes. The peritoneal cavity is opened, the outer layer of the mesocolon divided, the colon pushed toward the median line, and the tumor loosened and

brought forward either before or after the ligation and division of the vessels which may enter it.

Nephrectomy in Two Steps.—Favre advises the extirpation of the kidney in two steps in order to lessen the risk. He bases this advice upon the fact that many rabbits from whom one kidney was removed suffered from fatal parenchymatous nephritis of the other organ of a bacterial nature. He found that this nephritis did not occur if the second kidney was in a condition of beginning

FIG. 151.



Langenbuch's incision for transperitoneal nephrectomy.

hypertrophy at the time the first kidney was removed. He produced this result by ligating the ureter for fourteen days before removing the kidney. The kidney whose ureter was ligated, excreted a certain amount of urine for a few days, during which time the functional activity of its fellow was much increased. When finally the day for extirpation arrived the animal did not suffer from it, since it had been for some days deprived of the benefits of excretion from this kidney. These experiments have little practical value since sound kidneys are not removed.

Clinical Results of Extirpation of the Kidney.—Physiologists have

known for a long time that the kidneys are capable of doing a greatly increased amount of work. For example, by changing the character of the diet the amount of urea excreted may be made to vary from 22.4 grammes to 53.2 grammes in twenty-four hours. Furthermore, there are individuals who are born with a single kidney which not only performs the work of excretion satisfactorily, but which may be so increased in size that its weight is nearly equal to that of two normal kidneys. It is also well known that the gradual degeneration and loss of function of one kidney as the result of suppuration, connective-tissue contraction, pressure-atrophy in uronephrosis, etc., may take place without much change in the total amount of excretory products. One often sees at autopsy how small an amount of kidney tissue has for years proved sufficient for the organism. It appeared therefore probable if one kidney were suddenly removed that the other would be able to take up its work, and that in doing so it would probably become hypertrophied and increase in weight. This belief was confirmed by experiments on animals and by operations upon man. Simon found that after the removal of one kidney the daily quantity of urine is diminished to about one-fourth for a day or two. This urine contains, however, about double the amount of urea which the same quantity of normal urine contains. In six days the total quantity of urine voided was 1010 c.c. (34 ounces), while in twelve days it had increased to 1300 c.c. (43 ounces). At this time the specific gravity was normal, and the urine contained the normal amount of urea. It has been repeatedly shown since Simon's time that such is the normal result of the extirpation of one kidney. The quantity of urine which the remaining kidney excretes is influenced by a variety of circumstances. If the extirpated kidney is already thoroughly degenerated, its removal has little or no effect upon the urinary excretion of the other kidney except in so far as this may be influenced by loss of blood or the anæsthetic, or the duration of the operation, etc. There will be, also, a moderate depreciation in the amount of urine for a day or two as the result of the scanty diet. Even the sudden removal of a healthy kidney can be easily endured. Schede was obliged to remove a large piece of ureter in taking away a carcinomatous uterus. The ureter was ligated and two days later this kidney was removed. In spite of this double operation the remaining kidney excreted 600 c.c. (20 ounces) of urine on the day of the second operation, 1000 c.c. (33 ounces) on the following day, and 1400 c.c. (46 ounces) on the third day. Thus it was shown that the second kidney was able in a remarkably short time to take upon itself the work of both.

This happy result does not always follow a nephrectomy. Sometimes the urine remains scanty for a long time and contains abnormal elements, such as blood, albumin, and casts. Indeed, these elements are frequently found in small amount in the first few days after

extirpation. They may, however, be present a much longer time and the patient still recover.

The result of operation may be a still less favorable one. For example, on the day of operation the patient may pass 300 or 400 c.c. (10 or 13 ounces) of cloudy urine containing albumin and casts; on the following day the quantity may be only 150 c.c. (5 ounces), while on the third day there may be total anuria, with rapid death. This sad result may not only follow an operation of difficult character requiring a good deal of time for its performance, and accompanied with a loss of much blood, but it may also follow—as in one of Israel's cases—the simple shelling out of the remnants of kidney from an old uronephrotic sac which had not been drained for a long time. Examination of the remaining kidney under such circumstances shows that the epithelium of the convoluted tubules is swollen, often filling the lumen of the tubules, while the nuclei of the cells are indistinct and have lost the power to take up a stain. This degeneration is not everywhere equally apparent, but is so widespread that it appears in every field examined. The glomeruli, the pyramids, and the vessels of the kidney appear unchanged.

There may be another termination to the operation. The patient may excrete from 600 to 1600 c.c. (20 to 53 ounces) of urine, which is usually very concentrated, and contains much albumin and many red blood-cells. This will last for a week, or possibly two weeks, during which time the urine may improve. Then the quantity of urine gradually sinks below the normal, growing less each day. It contains a trace of albumin, but a great quantity of hyaline and waxy casts and degenerated renal epithelium, and the patient dies. At autopsy there will be found fatty degeneration of the heart, liver, and kidneys, and microscopical examination of the kidney will show that the degeneration has affected not only the convoluted tubules of the glomeruli, but also the straight tubules, most of which will be found choked with detritus and some connective-tissue fibres.

Such a condition is undoubtedly the result of coagulation-necrosis and acute fatty degeneration. These changes may be found in the liver and kidneys after death by acute poisoning, so that the question is at once raised as to whether after removal of one kidney the patient dies from poisoning, and, if so, what is the source of the poison. Sänger's experiments upon animals show that bichloride of mercury, carbolic acid, iodoform, boric acid, and salicylic acid, if given in large doses can produce exudation in the glomeruli and their capsules, round-celled infiltration, formation of hyaline casts, etc. It must be admitted that the removal of one kidney would naturally leave the other more sensitive to the effect of poison than if two kidneys were present as in most operations upon the body. However, these explanations are not altogether satisfactory since fatal changes in the remaining kidney have been observed when the extirpated kidney was in such a condition that it could not

have assisted in the excretion for many months. Moreover, the same changes have been observed when no antiseptics were used at the operation. Under such circumstances one must seek another cause, and some have thought to find this in the anæsthetic employed —chloroform or ether. The reports of experiments and cases bearing upon this point have not always agreed. American surgeons have long insisted that ether may act injuriously upon a diseased kidney, while Fränkel and others have shown that long-continued administration of chloroform may produce serious changes in the renal epithelium cells, in the cells of the liver and heart, sufficient at least to aid in a fatal termination. Eisendraht carefully analyzed the urine of 70 patients who had taken chloroform, and the urine of 60 who had taken ether. He found epithelium in the urine of 25 per cent. of the healthy persons who had inhaled ether, and in 32 per cent. of those who had inhaled chloroform. In addition to the albumin, casts were often found. If the urine before operation contained albumin, the amount was markedly increased by the etherization. The effects of chloroform in this direction were not so constant, but when they did occur they lasted much longer than those due to ether.

If such be the results of an ordinary anæsthesia, it is easy to understand that they may be more severe if the patient is weak, and the operation is difficult or long continued. If, in addition, a patient has but a single kidney to eliminate the poison which the body has absorbed, it is readily seen that injurious effects upon its epithelium will be greatly increased. Another possible cause of the damage done to the remaining kidney is the sudden increase of blood-pressure which must follow ligation of an artery of the kidney to be extirpated. The practical conclusions to be drawn from these facts are as follows: (1) to limit the amount of antiseptics employed in nephrectomy, or, if possible, avoid their use; (2) to adopt methods of operation which permit easy exposure of the kidney and facilitate a rapid termination of the nephrectomy; (3) to make use of the smallest possible quantity of chloroform or ether, preferably avoiding chloroform.

Some surgeons have claimed that the remaining kidney is especially liable to disease in future years. This claim has not been proved. Graser collected reports of autopsies upon 116 persons who were born with only one kidney. He found that nearly half of these individuals died of kidney trouble, while no less than 20 per cent. of them suffered from renal calculus. Schramm calls attention to the fact that the hypertrophic kidney of pregnancy is especially prone to congestion, and that albuminuria, nephritis, and uræmic attacks occur much more frequently under such circumstances than they do when the condition of the kidneys is normal. Still, the clinical results of nephrectomy do not seem to warrant such gloomy prognoses, although they have not been collected on a sufficiently large scale to settle the question definitely. Schede was

able to trace the majority of 59 patients for a period of six years or more after nephrectomy, and found that not one of them suffered from renal trouble, while many of the women afterward gave birth to healthy children.

Anatomical Changes in the Remaining Kidney.

Compensatory hypertrophy of the kidney may be the result of a gradual destruction of the other organ, or of its congenital absence, or of its removal by operation. This process may go on until the remaining kidney weighs as much as two normal kidneys. It is important to know whether this increase in size is due to hyperplasia, that is to say, to actual increase in number of the glomeruli and tubules ; or whether it is simply a hypertrophy, that is to say, an enlargement and lengthening of the structures normally present. Such a question is difficult to settle, and the answer must ultimately rest upon the results of actual counts and measurements of glomeruli and tubules. At first the results of different observers varied widely, but the later investigators more nearly agree, especially since they have separated congenital absence of one kidney from the acquired loss of one kidney. Eckardt finds that in extra-uterine life a kidney may physiologically increase in size by a continual growth of the glomeruli until the growth of the body is completed. He finds, also, that the convoluted tubules may increase in thickness and length until the fourth year of life. After this age they may simply increase in length.

If one kidney is lacking at birth, the increase in size of the other may be due to both hyperplasia and hypertrophy. The glomeruli greatly increase in size, and the convoluted tubules grow longer and larger and may also increase in number.

If one kidney is lost after birth, the compensatory increase in size of the other is due entirely to growth of the glomeruli and to increased breadth and length of the convoluted tubules, but not to hyperplasia. The cortical layer of the kidney is noticeably broader than usual.

RESECTION OF THE KIDNEY.

Surgery of the kidney has been growing gradually more conservative. Thus the movable kidney was at one time extirpated. At present it is sutured. The kidney containing calculi and the uronephrotic kidney formerly were extirpated. Now they are incised and a plastic operation is perhaps performed upon the ureter. Hence it is natural that one should attempt to save a portion of the kidney by resecting a part of instead of removing the whole organ. Czerny in 1886 resected a portion of the kidney in which an angiosarcoma developed after a fall. He closed the wound partly by suture and partly by gauze. The wound healed well, but

the patient was lost sight of within a year. Experiments upon animals show that portions of the kidney can be resected, and the wounds if sutured heal by primary union. In the last fifteen years many cases of resection have been reported which show that it is possible for the human kidney to heal either primarily or by granulation. A fistula is likely to follow if the pelvis of the kidney or the ureter is wounded. The principles of partial resection have been successfully applied in the treatment of tuberculosis of the kidney. Israel has removed nearly one-half the organ with success.

Other operators have removed a portion of the kidney for malignant disease, while many times a small section of the kidney has been removed for the sake of microscopical examination. From these facts it is evident that resection of the kidney has a proper place in surgery. It is not a dangerous operation, and in a certain number of cases it may produce a complete cure. Whenever the circumstances are such that this is possible, the more serious extirpation of the kidney ought not to be performed. It is not well determined just what are the indications for the performance of resection. Certain cases of traumatism, of fistula, of limited inflammatory processes and benign tumors are evidently suited to this method of treatment. It is not so clear that the operation is the proper one to perform in cases of tuberculosis, although the resections which have been made for this disease have sometimes been followed by good results. In the case of malignant disease it is even more doubtful whether resection is advisable. If the other kidney is known to be sound, it is far better to remove the affected organ entirely. If it is known or suspected that the other kidney is diseased, partial resection may hold out the hope of some improvement.

There have been instances in which the half of a small horseshoe kidney has been removed on account of uronephrosis, calculus, pyelitis, or malignant disease. No troublesome hemorrhage followed division of the isthmus. This operation is properly classified as occupying a middle ground between partial resection and total extirpation of one kidney.

The incision in the kidney for resection varies according to the case. Thus, if a benign tumor, a cyst, or an echinococcus cyst is to be removed, the incision in the kidney should be so directed that the remaining portions of the organ are easily sutured. The portion excised is wedge-shaped, and the incision may be directed transversely or longitudinally. Transverse incision permits a more radical removal of tissue, but longitudinal incision gives rise to less hemorrhage. It frequently follows that one must split the kidney on its convex surface in order to determine how far the diseased tissue extends before an attempt is made to remove it. Small areas of tissue may be scooped out with a sharp spoon. Hemorrhage may

be controlled by digital pressure upon the hilus of the organ or by specially constructed clamps or an elastic ligature.

The chief point in the after-treatment is the prevention of hemorrhage, which is more likely to follow in transverse resection if the incision is carried near to the hilus. A ligature should be passed around the larger vessels by means of a curved needle. For the most part bleeding will be stopped by the suture, if the cut surfaces are healthy and fairly even. If suppuration is present, there can be no suture of the wound in the kidney, but this may be seared with the cautery if the surgeon so prefers, and tamponed with iodoform gauze. The suture of the remaining portion of the kidney into the wound in the skin, as recommended by Kümmell, facilitates tamponing of the kidney and protects the patient from hidden hemorrhage. Other measures which are recommended for this purpose are the suture of a tampon into the kidney itself, or the suture of a tampon upon the surface of the organ if the wound is superficial.

Many experimenters have written upon the methods of repair of a wounded kidney. At first it was believed that repair was dependent upon extravasated white blood-corpuscles. Later it was claimed that the connective tissue of Bowman's capsules and between the tubules sprouted into granulations from which later a regeneration of the glandular elements took place. In 1889 Tuffier announced that after the degeneration which formed in the immediate vicinity of the wound had passed over that there was an extensive new formation of glomeruli not only in the vicinity of the wound, but throughout the whole organ as well. This new formation took place very rapidly, so that in the dog it was complete in two weeks, and he found that it went on to such an extent that he was able to resect at different times portions of kidney substance equal in weight and apparent efficiency to both of the normal kidneys without producing death of the animal. But later experiments showed that Tuffier was mistaken, and that compensatory hypertrophy of the kidney takes place without new formation of glomeruli.

On account of the system of terminal arteries which exists in the kidney the effects of traumatism are severe. But they are the least marked when long, wedge-shaped pieces are excised from the convex surface. If an arterial trunk is injured, there follows a well-marked pyramidal necrosis of the tissue supplied by it. Sometimes the necrosis is confined to the immediate neighborhood of the wound, sometimes there is a more or less extensive zone in which retrogressive metamorphosis takes place, marked by cloudy swelling and fatty degeneration of the epithelium, a homogeneous or finely granular exudate in the tubules, which may also contain the nuclei and other fragments of desquamated epithelial cells. These changes are more marked in the convoluted than in the straight tubules. Some changes are observed in the glomeruli of the affected

zones, in which even the cells of the capillaries undergo fatty degeneration.

Along the border of the necrotic zone regenerative processes take place at an early period; the nuclei of the cells will be found to be divided as early as the second day. These active changes are much more pronounced in the epithelium of the tubules than in the glomeruli. At the same time the endothelium of the intertubular capillaries and the outer cells of the vessel-walls and the connective-tissue cells of the fibrous capsules are found in a state of active proliferation. The intertubular spaces are filled with serum and leukocytes, and the whole kidney is hyperæmic.

In general the growth of the connective tissue exceeds that of the epithelium, and many of the tubules become atrophic as the result of the pressure of the interstitial connective tissue. Especially in the zone of necrosis the tubules shrivel more and more. In other portions of the kidney the epithelial regeneration is more active, so that some authors have spoken of a new formation of tubules. The strings of epithelium which are sometimes found in the connective tissue have no physiological importance. It is certain that new glomeruli are never formed, nor is there any new formation of true glandular tubules. Tuffier and those who repeated his experiments were evidently deceived by the inflammatory swelling of the kidney, which was kept up and increased by repeated operations upon the organ. However, it is admitted by all that hypertrophy of the portion of the kidney which remains after resection may take place to a marked degree. Thus, the right kidney of a dog was removed and found to weigh 18.2 grammes (0.6 ounce). Five weeks later about a third of the left kidney was resected and found to weigh 6 grammes (0.4 ounce). After two years the remnant of the left kidney was found to weigh 57 grammes (2 ounces)—that is, about three times as much as the right kidney at the time of its extirpation. This is an unusual increase. There are numerous instances in which the remains of a kidney may hypertrophy until its weight is double that of the normal organ. In such kidneys the diameter of the glomeruli is doubled or even tripled, while that of the tubules is slightly increased. Furthermore, the epithelial cells of the tubules increase in size and probably in number.

TECHNIC OF NEPHROTOMY.

Extirpation of the kidney is now universally known as nephrectomy, while the term nephrotomy is used to indicate a simple incision of the kidney for diagnostic or therapeutic purposes. Nephrotomy is a strictly conservative operation intended to free the organ from the cause of disease or from its effects while not depriving the body of the renal function. It stands, therefore,

in sharp contrast to nephrectomy, whose territory it has greatly reduced in the last ten years. By means of this operation many kidneys are saved which, in accordance with the ideas previously held, would have been sacrificed in spite of the fact that they contained considerable healthy parenchyma. This was done because no other method was known by which to free the patient from the disease which was dragging him down. The introduction of the operation of nephrotomy was therefore a long step forward in the surgery of the kidney. It is frequently used in the treatment of renal calculus, anuria, renal abscess, many forms of renal colic, and renal hemorrhage, as well as in the treatment of uronephrosis and pyonephrosis. The reader is referred to the chapters upon these diseases for the indications and results of nephrotomy. Attention has just been called to the fact that every wound in the kidney is followed by degeneration of the parenchyma adjoining it, and that the extent of this zone of degeneration depends upon the importance of the bloodvessels which have been destroyed. Hence it is of the greatest importance to the surgeon to know the exact course of the arteries of the kidney. This subject is treated at length in the chapter on Anatomy of the Kidney.

Zondek has shown that the best place to incise the kidney for the extraction of a stone is not exactly in the centre of its convex surface, but about 0.5–0.7 cm. (0.2-0.3 inch) posterior to this line. The incision should also be made slightly forward into the pelvis. In this manner one can usually avoid opening any large vessels if the incision does not extend beyond the limits of the middle third of the organ. Both the upper and lower poles are supplied with special arteries which are likely to be cut if the incision is extended into them.

The technic of nephrotomy varies according to its purpose. If a kidney contains calculi or pus, it should first be freed sufficiently to permit inspection of its whole surface. If the calculus is not associated with severe infection, an incision should be made in the middle third of the organ, as described above, the finger introduced into the pelvis, and the different calices palpated. If the process, however, is a suppurative one, the success of the operation will depend upon the fact that no abscess remains unopened. Therefore the incision must be long enough even at the risk of hemorrhage and at the expense of parenchyma. In the case of uronephrosis and pyonephrosis it may be necessary to extend the incision in such a manner that the beginning of the ureter shall be exposed.

Whatever the purpose for which nephrotomy is performed, the operation can be carried out more readily if hemorrhage is prevented by a clamp on the hilus, or, still better, by an elastic ligature bound about the hilus with no more force than is absolutely necessary to shut off the blood-supply. The parenchyma can withstand this artificial anæmia for about thirty minutes without injury. This method of operating saves the patient from the loss of a great

deal of blood, and makes the operation easier and more certain. If the kidney is aseptic, the wound should be closed by both deep and superficial sutures. If the kidney is suppurating, or if obstruction to the flow of urine is present, the wound should be left open and tamponed, and its edges may or may not be sewed into the wound through the muscles. A kidney which is incised on account of anuria should never be sutured. If the kidney is aseptic, primary union will almost certainly follow suture. The patient will pass fluid urine for a day or two, and then this will disappear and there will be no further symptoms. If the kidney is not sutured, almost all the urine that it excretes will pass through the wound for a considerable time. If the ureter is pervious, the wound in the kidney will close by granulations until only a fistula is left, or the closure may be complete.

Pyelostomy.—Pyelostomy, or incision of the pelvis of the kidney, is an operation seldom performed. It is an operation confined to a kidney which contains a calculus, or is uronephritic, and is therefore spoken of in the chapters devoted to these subjects.

CHAPTER XX.

THE SUPRARENAL GLAND.

A NUMBER of investigators have recently been trying to learn the physiological significance of the suprarenal gland. It has been demonstrated that the extract of this gland has an extremely stimulating action upon the heart. If suprarenal extract is injected into an animal whose heart has been stopped with chloral, within five seconds there will develop an unusual cardiac activity which will last for thirty minutes. Even if the injection of the extract is not made until the heart has ceased beating for five minutes, it will bring about renewed heart-beat, provided artificial respiration is kept up. Cyon believes that it has a paralyzing effect upon the vagus and the depressor nerves of the heart, and a stimulating effect upon the accelerator nerves. Other investigators have shown that removal of both suprarenals invariably kills frogs, tritons, and toads, while removal of one suprarenal does not cause death; and if so little as one-tenth of the suprarenal is left, the life of the animal will continue for one or two weeks. Such an animal becomes much emaciated in spite of a normal diet, and death follows when its weight has been reduced one-half or more. Death under such circumstances will be delayed by implantation of the suprarenal of another animal of the same species, but will not be delayed by implantation of the suprarenal of an animal of another species. This coincides with the experience of Jaboulay, who implanted the suprarenals of dogs in two patients suffering from Addison's disease. Both died with high fever within twenty-four hours. These experiments upon animals show that the suprarenal gland possesses a marked physiological importance. This conclusion has been confirmed by observation in man.

The name "Addison's disease" is given to a group of symptoms comprising bronzing of the skin, anæmia, marked emaciation, dulness, muscular weakness, palpitation of the heart, dyspnœa, gastro-intestinal disturbances, and sharp pains in the gastric and sacral regions. Under such circumstances the suprarenal gland is found diseased, usually being affected by tuberculosis. Kahlden and others have described as a typical Addison's disease cases in which bronzing of the skin was wanting.

Jonas says that the bronzing of the skin is not directly dependent upon the disease of the suprarenals, and that it does not exist in about one-sixth of the cases. Furthermore, in about one-eighth of the cases of bronzing of the skin disease of the suprarenals is absent. In one case bronzing was doubtless due to pressure of the aneurism

upon the left splanchnic nerve. Jonas takes the view that Addison's disease is the result of an affection of the sympathetic ganglion lying near the suprarenal, and which in its progress involves the suprarenal. He believes that the disease is curable up to the time when the suprarenal becomes involved.

Diseases of the suprarenal gland have heretofore been interesting chiefly to physicians. Still, there are isolated instances in which surgical treatment has proved of benefit. More than 80 per cent. of diseases of the suprarenal are of a tubercular nature, and some observations show that a unilateral tuberculosis may lead to the most serious consequences. Hence the question arises whether removal of the diseased organ might not benefit the patient. There are a few cases which seem to uphold this view: first is one in which operation was performed by Hadra upon a woman, aged fifty-five, in whom for about a year characteristic symptoms of Addison's disease had been present. Palpation of the greatly emaciated abdomen revealed a warty, movable, tender tumor to the left of the aorta, which was for a time supposed to be a gastric carcinoma. At operation it was found to be a much degenerated suprarenal gland, which was removed without especial difficulty. The patient recovered, and nine months later was in good health. Jonas also removed a diseased suprarenal with success, although he was compelled to remove the kidney on account of the close adhesions existing between the organs. The bronzing of the skin disappeared entirely within three weeks after the operation.

Helferich successfully removed a tuberculous suprarenal gland through a lumbar incision and cured his patient.

True tumors of the suprarenal gland are rare. Adenoma is the commonest of the benign tumors, and occurs either single or multiple. It is marked by small yellowish nodules in the cortex of the suprarenal or larger nodules springing also from the cortex, and usually solitary and involving only one side of the gland. Other benign tumors which have been found are fibroma, lipoma, angioma, and lymphangioma, but no case is on record in which a surgeon has been called upon to remove such growths.

Nicoladoni mentions the occurrence of enormous encapsulated hæmatomata.

Malignant tumors have seldom been subjected to surgical treatment, and as far as known never with permanent cure. Rolleston and Marks succeeded in collecting records of 26 cases of primary malignant tumors of the suprarenal, 9 of which were malignant adenomata or carcinomata, while 15 were sarcomata. Metastases formed chiefly in the liver, while the bronze color of the skin, so noticeable in Addison's disease, was wholly or nearly wanting.

The success of surgical treatment naturally depends upon the early diagnosis, and owing to the concealed position of the suprarenal this is not likely to be made. These tumors show a high

degree of malignancy. This is an additional reason why extirpation to be of benefit must be undertaken very early.

It is in the nature of a happy accident if a tumor of the suprarenal gland is recognized before it begins to press upon the kidney; even then attention may simply be directed to the increased size of the kidney, the symptoms being the same as those which would be produced by a tumor of the upper pole. The only point which can be made out by palpation will be a slight descent of the lower pole of the kidney, for in few instances will it be possible to determine that the kidney is pushed downward as a whole by something pressing above it, and to which it is not intimately attached. The exact differential diagnosis between a suprarenal tumor and one of the upper pole of the kidney is not of much practical importance. As long as the tumor is movable it may be extirpated whether it occurs in one or the other organ, and when it becomes immovable operation cannot be of benefit. In doubtful cases in which the tumor seems to be on the dividing-line between an operable and an inoperable condition it is well to oppose delay, since malignant tumors of the suprarenal infect their neighborhood relatively early. On account of their situation at the side of the spinal column they often involve the nerves which come out between the vertebræ, and produce painful attacks. A new growth of the right suprarenal will early produce venous congestion on account of its close attachment to the vena cava, and it may interfere with the flow of blood through the renal vein. Furthermore, contact of the suprarenal with the diaphragm exposes the pleura to the risk of an early infection. Symptoms which may be explained on any of these grounds must be considered counterindications for any operation.

If it is decided to extirpate a movable tumor, the diagnosis will usually be that of a tumor of the upper pole of the kidney, and a correct diagnosis will not be made before operation. The practical result of this mistake is slight, since in the majority of cases the kidney must always be sacrificed, either because it is involved, or because it obstructs the path to the suprarenal. Nevertheless instances are on record in which a tumor of the suprarenal has been removed without injury to the kidney.

The operation may be carried out through either a lumbar or an abdominal incision, just as in operating upon tumors of the kidney. If the retroperitoneal method is chosen, it is well to make at the outset a large incision. In most of the cases thus far operated upon, the abdominal incision was made at first or during the operation. In only two instances has operation been carried out through a lumbar incision alone. Nevertheless it is probably the operation of the future.

In the case of malignant tumors it is all-important that the operation should be radical. In the case of tuberculosis or benign tumors, the surgeon should follow Jonas' advice and spare, if possible, the semilunar ganglion.

ABNORMALITIES, INJURIES, AND DISEASES OF THE BLADDER AND PROSTATE.

By Prof. M. NITZE and Prof. E. SONNENBURG.

CHAPTER XXI.

PHYSICAL EXAMINATION OF THE BLADDER.

Diseased conditions of the bladder may be recognized by the eye, by touch, and by the ear. Examination may be made from without or from within its cavity. It may be made through the abdominal wall, through the rectum, or through the vagina, or directly through a suprapubic incision.

The distended bladder of an old, thin man, who suffers from prostatic hypertrophy, can easily be seen as an oval swelling whose summit is directed upward and slightly to the right of the median line. A prominent diverticulum of the bladder or a tumor of its vertex may also be visible through the abdominal wall.

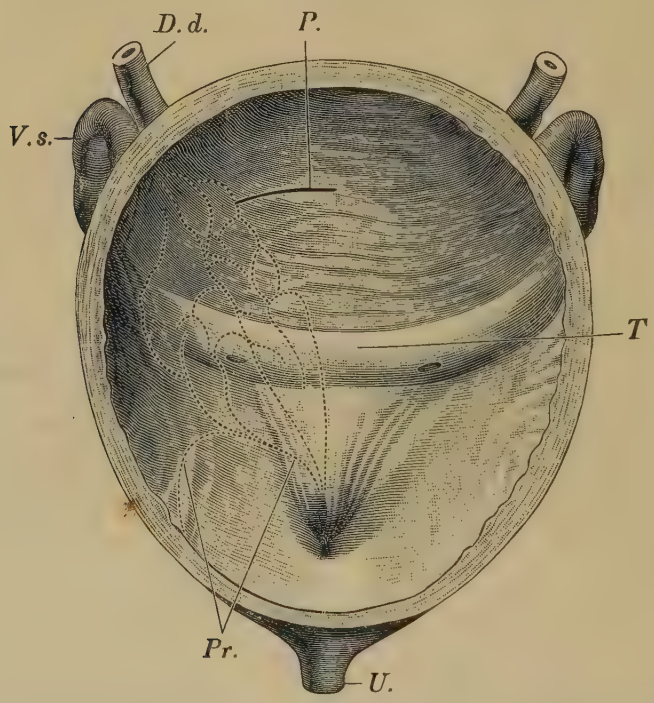
If the distended bladder is in contact with the abdominal wall, percussion gives a flat note. If percussion above the symphysis gives a tympanitic note, it is not safe to infer that the bladder is empty, since loops of intestine may lie between the bladder and the abdominal wall, even when the bladder is distended.

In many cases palpation is a more reliable means of examination than inspection or percussion. It is chiefly of value in thin individuals and when the bladder is markedly distended. The patient lies upon the back, and the surgeon presses with his fingers below the umbilicus until he feels the pulsation of the aorta. This he follows downward until his fingers pass the promontory and sink into the pelvis. If the bladder is distended and the abdominal walls are relaxed, the fingers can map out the upper portion of the organ. It is scarcely possible to feel a bladder which contains less than 200 c.c. (7 ounces) unless the patient is anæsthetized. If the bladder is much dilated, it may contain several hundred c.c. of fluid and still escape the examining fingers. A bladder which is fully distended feels tense and often very hard; pressure upon it excites the desire to urinate. Under favorable conditions one can feel a diverticulum of the bladder or a hard tumor of its wall. Only in rare cases is it possible to recognize a calculus of the bladder by suprapubic examination.

Rectal palpation is chiefly of service in determining the characteristics of the prostate; but if the prostate is not enlarged and the surgeon's finger is long, he can in many cases recognize the base of a distended bladder above the prostate as a fluctuating mass.

Bimanual examination, with two fingers in the rectum and the other hand above the symphysis, is of great service when the patient is anæsthetized. The bladder should be empty. When the muscles are fully relaxed, the surgeon can compress the bladder between his fingers, and recognize hard objects within its cavity and estimate the

FIG. 152.



Base of bladder showing, *T*, trigonum. The boundaries of the seminal vesicles and the prostate are indicated by dotted lines, the peritoneum by, *P*, a full line; *V.s.*, seminal vesicles; *D.d.*, vas deferens; *U.*, urethra; *Pr.*, border of prostate. (Zuckerkandl.)

thickness of its wall. If a sound is introduced into the bladder, examination of its base is still more accurate. This method of bimanual palpation is rendered more exact if the bladder is exposed suprapubically by an incision down to its outer wall.

In woman the bladder is even more accessible to examination than in man. Bimanual palpation will reveal the presence of a calculus or tumor, as well as the condition of the lower ends of the ureters.

The cavity of the bladder may be explored by instruments passed

through the urethra or through an opening surgically made. In this manner the bladder may be inspected and palpated.

The instruments which are of service in examining the bladder through the urethra are the catheter, the sound, and the cystoscope. Even a soft elastic catheter will sometimes reveal the presence of a calculus by the grating which is transmitted when it rubs against it. This instrument also shows whether the bladder completely empties itself. After normal micturition only a few drops of urine can be obtained through a catheter. If the bladder is incapable of fully emptying itself, more or less urine remains, which may be drawn through a catheter and is known as residual urine. Through the catheter fluids may be injected into the bladder in order to determine its capacity, and also to show whether it distends easily or with pain. If fluid is injected into the bladder with considerable force, and then is allowed to flow out quickly, small calculi, bits of tumor, etc., may be obtained which are of great value in making a diagnosis.

A metallic sound used for examining the bladder may be solid or hollow, like a catheter. A solid instrument is heavier, gives a louder click against a calculus, and is less likely to carry agents of infection than a metallic catheter. With a catheter it is, however, possible to examine the bladder in different stages of distention. The shape of the instrument's beak is of the greatest importance. All instruments with a long beak bent at a large angle, should be rejected, since they have not sufficient freedom of motion in the bladder. The best type of instrument is shown in Figs. 153 and 154. These instruments have a short beak and Mercier's curve. In both the shaft is more slender than the beak, measuring 19 mm. (0.75 inch) in diameter. Both have a cylindrical handle.

The patient lies upon the back with the pelvis raised upon a hard cushion. This is absolutely necessary if the enlargement of the prostate requires the handle of the instrument to be pressed far backward. The thighs are slightly flexed and abducted. The pain sometimes caused by the depression of the handle of the instrument is modified if the surgeon places his left hand upon the symphysis and presses downward so as to stretch the suspensory ligament of the penis. In certain cases it is preferable to examine the prostate through the rectum before passing urethral instruments. If the prostatic portion of the urethra is very long, a long instrument should be chosen, otherwise while the beak of the instrument is still in the prostatic portion of the urethra the surgeon may suppose it to be in the bladder.

When the instrument's beak reaches the bladder, it should be moved about systematically, and not turned at random back and forth. The surgeon should hold the handle between the tips of his thumb and fingers so as to favor delicacy of touch. The beak is first pushed against the posterior wall in order to determine its elasticity. The normal vesical wall is thin, soft, and elastic.

If it is hypertrophied or contracted, the resistance offered to an instrument is greatly increased. When the beak is passed from side to side, the size and symmetry of the vesical cavity will be shown. When one rotates an ordinary sound in a normal bladder,

Fig. 153.

Thompson's stone-searcher.

Fig. 154.

Guyon's stone-searcher.

the beak strikes against the fundus and prevents complete rotation unless the handle is deeply depressed. Hypertrophy of the prostate often produces dilatation of the base of the bladder, so that the sound can be rotated even though the handle is not depressed. The

size and shape of such a distention can often be mapped out with even a short-beaked sound. The existence of diverticula of the

Fig. 155.

Fig. 156.

Fig. 155.—A modern cystoscope whose beak has a Mercier curve. *a*, tiny electric lamp which is imbedded in the metallic tip of the instrument, *A*. The direction of the lamp corresponds to the knob *W* in the handle of the instrument, *C*, *e*, prism, one of whose surfaces acts as a mirror to reflect the rays of light. In the shaft (*B*) of the instrument is a system of lenses which cause objects at a certain distance to appear of natural size. If they are brought closer to the prism, they are magnified, and with further removal they are minimized.

Fig. 156.—Irrigation cystoscope.

bladder is often shown by the catching of the sound as it passes over the ridges between them.

In prostatic hypertrophy, if the sound is withdrawn until the beak is caught in the urethral orifice and then rotated, one can easily recognize the cylindrical projections of the urethral mucous membrane. The results of examination in patients with calculi and tumors are described more particularly in the sections on these subjects.

The cystoscope reveals to the eye the contents of the bladder and its lining membrane. As far as known, Bozzini was the first to attempt cystoscopy in the beginning of the nineteenth century. Later Desormeaux examined both the urethra and bladder with an endoscope. He made use of light reflected through a tube. Only a small portion of the bladder could be examined in this manner, and the light lacked intensity. Two improvements were necessary to make the cystoscope practical. They were, the introduction of lenses to increase the field of vision, and an electric light within the bladder itself. In the cystoscopes made up to the year 1879 the light was obtained by heating a platinum wire by galvanic electricity. This light was powerful, but it gave off so much heat as to require a stream of water to keep it cool. This made the cystoscope expensive and clumsy. With the introduction of Edison's electric lights, which give little heat, the cystoscope became a practical instrument. (Fig. 155.)

In certain cases cystoscopy is facilitated by irrigation. Instruments are made in whose shafts there are one or two canals so that water may flow in and out while inspection is going on. With such an instrument (Fig. 156) one can examine the bladder in different states of distention while the prism and electric lamp are kept clean. The observer may also note movement of papillary tumors, calculi, etc.

There are three requisites to successful cystoscopy. The urethra must be in such condition as to permit the easy introduction of the cystoscope without fouling of the lens and prism. The bladder must be sufficiently distended to permit free motion of the beak of the instrument. During the examination there must be some transparent fluid in the bladder. To obtain these three conditions in diseased states requires often both skill and patience. The simple cystoscope measures about No. 21 French. The bladder should contain from 100 to 150 c.c. (3 to 5 ounces) of fluid. If the urine is mixed with blood or pus, constant irrigation during cystoscopy is necessary. It is useless to introduce the cystoscope unless the three conditions here described are obtained.

The patient lies upon the back with the pelvis slightly projecting beyond the end of the table and the feet raised upon supports, so that the knees may be bent and widely separated. The shape of the cystoscope permits its easy introduction. The examination should cause little or no pain. Still, it is well to anæsthetize the urethra

PLATE XIV.

Cystoscopic Views of Vesical Calculi. (Nitze.)

Fig. 1 represents the mucous membrane and the arrangement of the vessels in the healthy bladder.

Fig. 2 represents a condition which is very frequently found and is almost typical; both lateral lobes are hypertrophic and form large symmetrical prominences encroaching upon the interior of the bladder; the internal orifice is situated between them. At the point of the angle a small piece of mucus is seen adherent.

Fig. 3. Phosphatic concretion from a patient suffering from prostatic disease; to the right a part of the hypertrophic fold of the internal orifice is seen.

Fig. 4. Showing a uric-acid calculus and in the upper part of the figure the furrowed mucous membrane of the floor of the bladder.

Fig. 5. Showing villous tumor of the bladder.

Fig. 6. Recent miliary tubercles from the bladder of a patient, aged forty-three, forming groups of small globular nodules arranged very much like vesicles in herpes. They are sufficiently distinguished from the otherwise healthy mucous membrane by their dull-pink color.

by a solution of eucaine. Cocaine is dangerous and should never be employed. The surgeon should thoroughly familiarize himself with the technic of the instrument before introducing it. He will then be able to make a complete examination in a short time. By following certain rules every portion of the interior of the bladder can be brought into view with methodical accuracy.

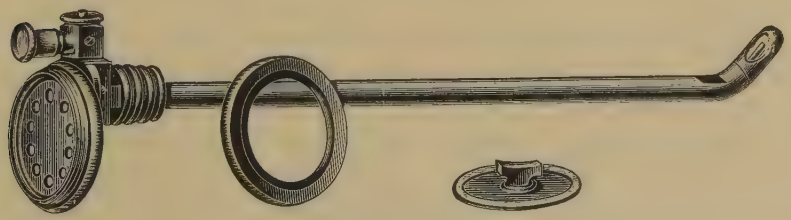
The mucous membrane of the normal bladder appears through the cystoscope a yellowish, rosy red. Here and there are seen delicate arterial branches similar to those seen in the retina of the eye. At the vertex of the bladder there is usually a bubble introduced by the catheter. Surgically, the most important portion of the bladder is the fundus. Here the ridges formed by the ureters stand out plainly and the mouths of the ureters are well marked. These structures may be seen to move as urine is injected through them into the bladder. One may even observe at times a peristaltic motion.

Catarrh of the mucous membrane reveals itself by redness and swelling and the presence of bits of mucus which have not been washed away by the previous irrigation. In acute catarrh the redness is most prominent, and in a chronic catarrh the swelling. These three evidences of inflammation are variously combined in the different fields of view.

In uncomplicated tuberculosis characteristic recent or degenerated nodules may be seen. In long-standing cases the bladder has somewhat the appearance of a chronic catarrh.

The changes of prostatic hypertrophy can be recognized with the cystoscope only in so far as they extend to the bladder. One can readily observe the folds about the internal urethral orifice, and can make out the conditions of the pouch which often forms above the hypertrophied prostate. If this pouch is deep, its complete examination will require a fuller distention of the bladder than is ordinarily necessary. The characteristic formation of diverticula and intervening network is clearly seen.

FIG. 157.



Cystoscope used for photography.

The appearances of calculi and tumors are described in the chapters on these subjects.

By means of a special eye-piece the field of vision through the cystoscope may be photographed. (Fig. 157.)

CHAPTER XXII.

CONGENITAL ABNORMALITIES OF THE BLADDER.

COMPLETE AND INCOMPLETE ECTOPIA.

Ectopia, or eversion of the bladder, is a congenital abnormality in which the abdominal cleft is usually associated with a cleft of the external genitals, of the urethra, and of the symphysis. The posterior wall of the bladder bulges forward like a tumor situated in the median line between the umbilicus and the urethra. In the male this is associated with epispadias of the rudimentary penis, while in the female the clitoris is cleft and the labia majora and minora are widely separated, and the urethra is altogether wanting. The umbilicus is usually situated at the upper edge of the tumor formed by the bladder, and may be so involved in the defect that it is found with difficulty.

Fissura Vesicæ Inferior.—There are different degrees of this abnormality. There may be simply a cleft in the lowest portion of the bladder, forming an opening 1 to 2 cm. (0.4 to 0.8 inch) across and situated in the normally formed symphysis.

Fissura Vesicæ Superior.—The cleft may be situated higher in the bladder close to the umbilicus, but without affecting the lower portion of the abdominal cavity or the symphysis, or the external genitals, or the urethra.

Fissura Vesicæ Umbilicalis.—The urachus may remain permanently open, giving a fistula extending from the umbilicus to the bladder. There are again variations in this condition, as sometimes the urachus is open throughout its whole length and sometimes only a portion of it remains patent.

A urachal fistula, or an umbilical fissure of the bladder is usually evident on account of the trickling of urine from the umbilicus. In the congenital form of the trouble the cause of the patency of the urachus may be the obstruction to the passage of urine by the natural channels due to phimosis. The first attempts at cure should therefore be directed toward making the natural outlet free. The urachus may be stimulated to close by caustics, or the cautery, or by the curette, or by suture. If these measures do not succeed, resection of the fistulous tract is indicated. This operation should be postponed until the child has attained at least half its growth. In the so-called acquired fistula of the urachus the epithelial lining of the dilated duct is the chief cause why the fistula remains open;

consequently it is necessary to split the fistula and remove its lining. As a usual thing the mucous membrane which lines the fistula cannot be dissected off as a distinct layer except in the portion of the urachus adjoining the malformed bladder. Here it should be cut square across and sutured. However, no fistula from bladder to umbilicus should be spoken of as a urachus fistula unless it is lined with epithelial cells. For example, other processes, such as suppuration, hypertrophy of the prostate, with cystitis and calculi, may produce a fistula leading from the bladder to the umbilicus which is not lined with epithelial cells; but even in these cases the location of the fistula is probably determined by the remains of the urachus.

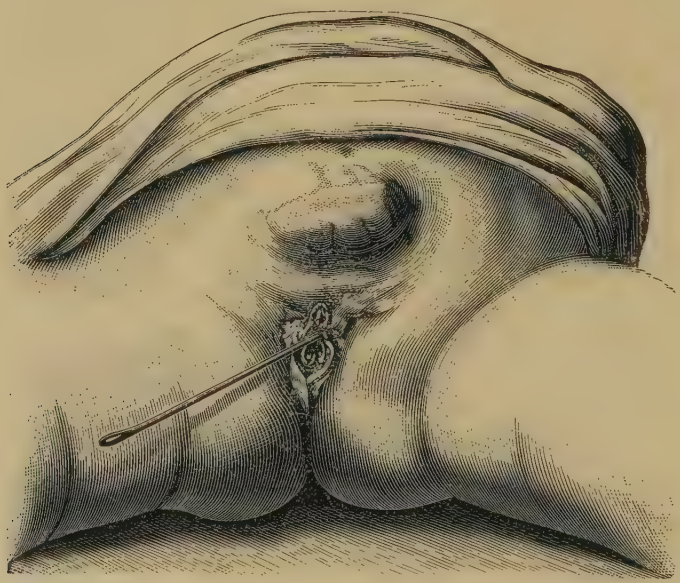
The complete cleft of the bladder is commoner in the male than in the female. The rudimentary penis, short and directed upward, is at the lower end of the cleft. The seminal vesicles with the openings of the seminal canals are visible in the posterior wall of the divided urethra. The head of the penis consists of two thick swellings beneath which the skin hangs down in the form of a little apron. The prostate may be normal, although usually it is rudimentary, and it may be wholly wanting. The scrotum may be unnaturally broad, and in many cases the small testicles lie on either side in contracted folds. In other cases the testicles are situated in the abdominal cavity or in the inguinal canals. Usually there are well-developed inguinal hernias. The changes which are found in the female consist in a flat mons veneris which lies between the external genitals and the prolapsed bladder. The urethra is wanting. If the clitoris is present, it is cleft. Even the internal pelvic organs, the uterus and its appendages, show the effects of the faulty union of the two lateral halves. There may be a double uterus each with its own vagina. These vaginas either terminate blindly or with fine openings in the region of the ureters, or between the bladder and the adjoining abdominal wall. The ovaries are widely separated from one another, and may or may not show irregularities of development.

In rare instances children have been born showing the effects of intra-uterine closure of a cleft of the bladder. Sonnenburg reports such a case, which is shown in Fig. 159.

Etiology.—The causes which underlie cleft of the bladder are not fully understood. The allantois, which is the urinary receptacle of the embryo, develops as a blind passage from the rectum. It is therefore a derivative of the intestinal layer and possibly owes its origin to the urine which is excreted by the embryologic kidneys and collects in the cloaca. The allantois, which exists only a short time, is originally double. Sometimes it persists in its double form on account of some difficulty in the fusion of the two halves. Rose thinks that the etiologic cause of cleft bladder is to be sought in the failure of the vesical ligaments (traumatic separation of the sym-

physis as a result of the fall of the mother). The bladder thus deprived of its natural supports tears open. Duncan, Müller, and Rokitanski attribute vesical cleft to bursting of the overfull bladder. This may be the result of atresia of the urethra or of some mechanical obstruction of the urethra. This theory rests upon the dilatation of the ureters and renal pelves so often found associated with vesical cleft. Kaufmann found that the secretion of urine does not begin until the end of the second month, long before which time the symphysis is formed. He therefore supposes that the symphysis becomes separated in those cases of vesical cleft in which it is found open. Kaufmann further attributes to the urinary retention the

Fig. 159.



Intra-uterine closure of vesical cleft. (Sonnenburg.)

delay in union of the external portion of the urethra and the head of the penis. After the bladder has burst, the parts of the symphysis may come together and unite, and the soft parts may similarly unite, and in this manner a complete intra-uterine restoration may take place, so that only the scar gives evidence of the previous cleft. Other writers, such as Meckel, Mörgalin, Winkel, Ahlfeld, and Steiner, look upon vesical cleft as an instance of imperfect development. A recent investigator, Reichel, reaches the following conclusions:

1. The majority of malformations of the urinary bladder and urethra, and especially the clefts of these organs, are simple failures of development.

2. The different forms of abdominal cleft and of epispadias occur on account of total or partial failure of fusion of the margins of

FIG. 160.

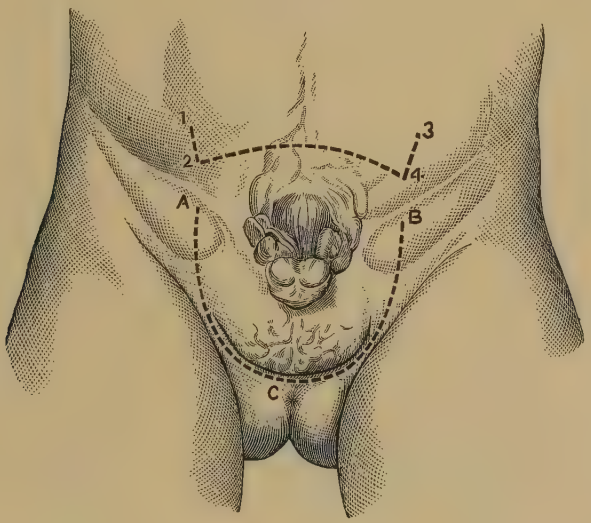
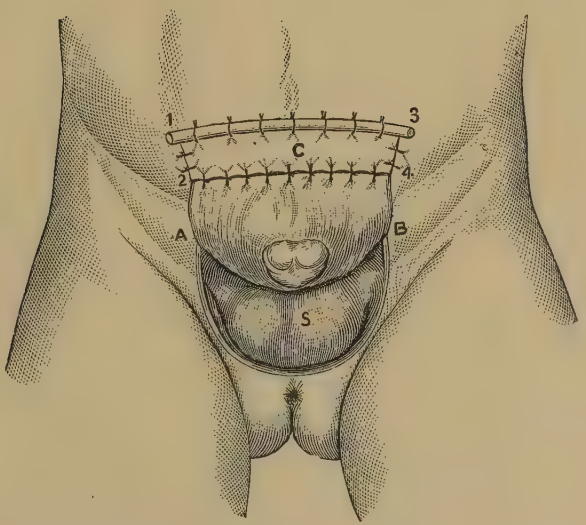


FIG. 161.



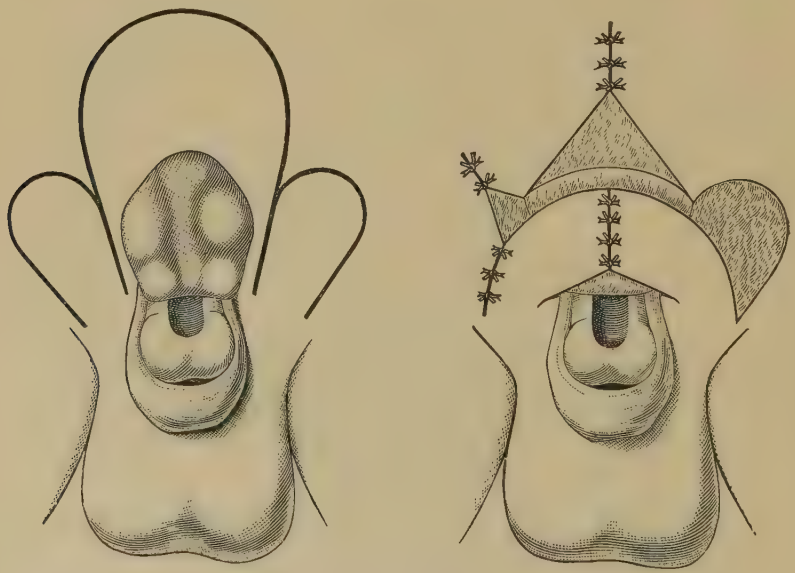
Roux's operation for ectopy of the bladder: *A*, *C*, *B*, outline of larger perineoscrotal flap; 1, 2, 4, 3, outline of smaller abdominal flap. (Hartmann.)

the primitive structures. It is possible that the presence of an amniotic fold may interfere with such fusion.

Treatment.—In spite of the great interest which has been taken in congenital malformations of the bladder at all times, the results of treatment have been very unsatisfactory. Operations may be generally divided into three groups: plastic operations, those which have for an object the union of the separated edges, and operations intended to divert the urinary stream.

Most plastic operations have for their object the creation of a vesical cavity, and perhaps a sphincter, by means of one or more flaps. In 1852 Roux first turned in a flap with the epithelial side directed toward the bladder. (Figs. 160 and 161.) This plan of procedure has since been variously modified. Nélaton cut the flap of skin from above the bladder, folded it downward, and stitched its edges to the freshened margins of the mucous membrane of the bladder, covering its raw surface with another flap cut from the scrotum. Wood utilized two lateral flaps to cover the raw surface of the first one. (Figs. 162 and 163.) In all

Fig. 162. Fig. 163.

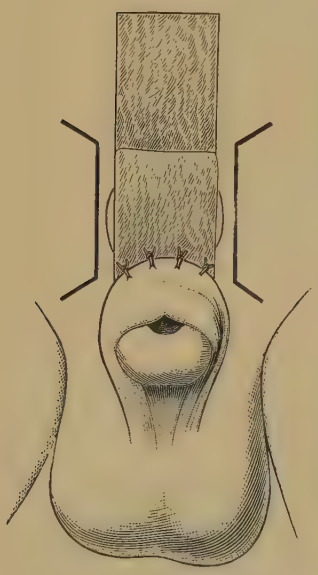


Wood's operation for bladder exstrophy, showing formation of flaps. (Hartmann.)

cases there arose further difficulties to overcome. If the defect is great, the flaps must correspond in size. Such flaps are apt to be poorly nourished and to become gangrenous in the region of the pedicle and on the edges, or the intra-abdominal pressure may force the bladder against the flap in such a way as to cause the stitches to tear out. Hence these operations are usually followed by fistulas which require subsequent operative measures. Even if the surgeon succeeds in closing the bladder, a serious difficulty

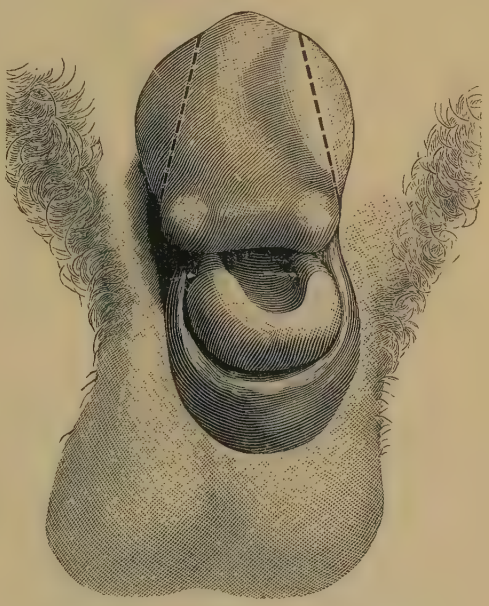
manifests itself: the hairs of the epidermis which is turned in to form a part of the bladder-wall give rise to calculi. Sometimes irrigations have been successful in removing the concrements, sometimes they have been extracted with instruments, and sometimes the surgeon has been compelled to incise the anterior wall in order to get rid of the stones. Under such circumstances the pain may be so great that the patient begs to be restored to his primitive condition, especially as there can be no continence of urine under such circumstances.

FIG. 164.



Le Fort's operation for exstrophy of bladder. (Hartmann.)

FIG. 165.



Segond's operation for exstrophy of bladder. (Hartmann.)

Holmes attempted to make the patient continent by a pad pressing on the root of the penis, while Wood sought to attain the same object by a rubber ring. These and similar measures have proved so unsatisfactory that it is better to recommend to such a patient the constant use of a urinal. Thiersch and Billroth tried to avoid the formation of calculi by directing the raw surfaces of the flaps toward the bladder. Thiersch made two lateral flaps whose median edge lay close to the periphery of the mucous membrane and the bladder in order that when they were subsequently stitched together the formation of a blind pocket might be avoided. These flaps were so large that either alone would cover the defect in the bladder. They were raised in the form of a bridge, being attached at either end, and a piece of ivory or gutta-percha was passed

Fig. 166.

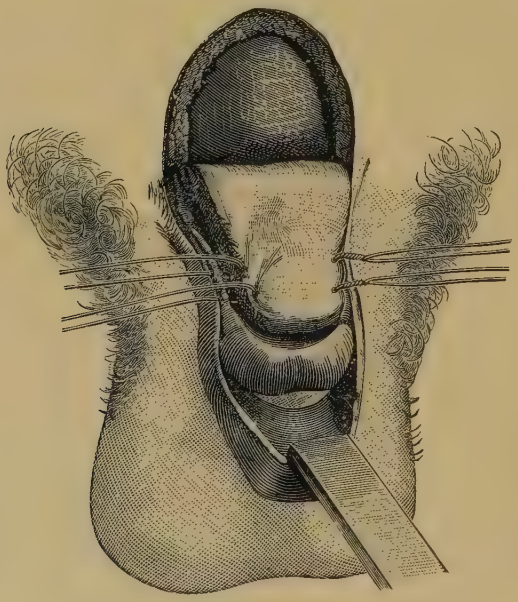


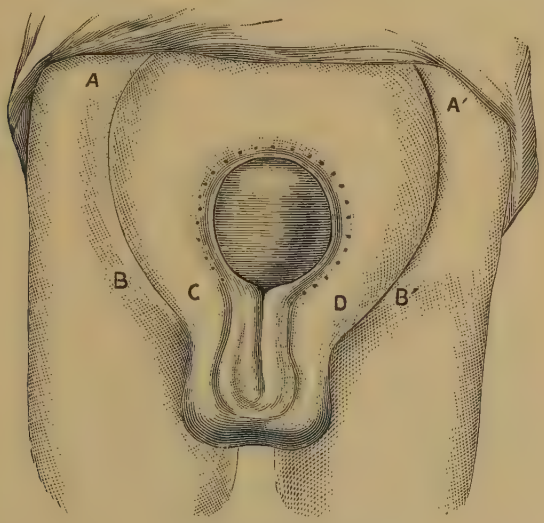
Fig. 167.

Segond's operation for exstrophy of bladder. (Hartmann.)

underneath them. Three weeks later, when granulation was well established, the flaps were separated at one end, and one was

employed to cover the defect in its upper portion and the other in the lower portion. But by this method complete closure of the vesical cavity was only obtained after numerous subsequent operations to overcome fistulas. The penis was restored by two opera-

FIG. 168.



Operation for congenital exstrophy of the bladder: *A B*, and *A′ B′* are two incisions including the recti muscles; *C D* is the purse-string Lembert suture of catgut in the bladder-wall. The lateral flaps are sutured in the median line, and the raw surface at the sides allowed to granulate. A catheter is placed in the neck of the bladder. (Tietze.)

tions, the first of which was the closure of the cleft urethra, and the second was the fastening of the head of the penis in a buttonhole made in the foreskin. Even in his most successful case Thiersch was unable to overcome the incontinence of urine. Moreover, his

FIG. 169.

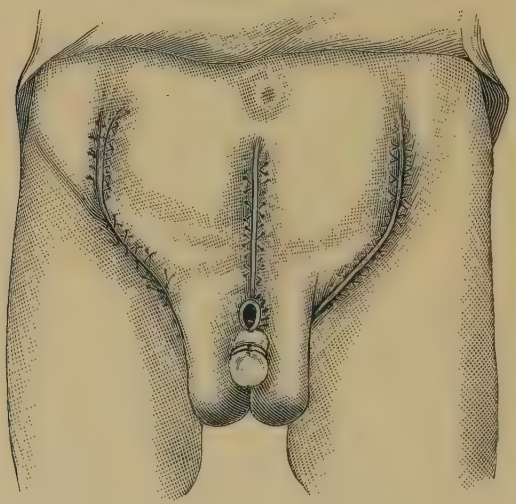
Showing formation of the urethra and the penis.

method has not proved itself free from the disadvantage of calculous formation, and most of the patients who have been thus treated suffered more or less from this cause, many of them to such an extent that it was necessary to reopen the vesical cavity. Certain

patients have been able to keep themselves fairly dry during the night by lying on the back and allowing the urine to collect in the newly formed vesical cavity; when in an upright position they had no continence, and were obliged to wear a urinal, for the pressure of the intestine pushed the posterior bladder-wall against the new-formed anterior wall and so practically obliterated the vesical cavity.

As Thiersch's method of operating prevents the formation of diverticula and dead spaces in the new vesical cavity, and introduces no growing hairs, some other cause must be assumed for the formation of calculi. It may be that the inner surface of the flap ulcerates, and that the degeneration of the urine which is the result favors

FIG. 170.



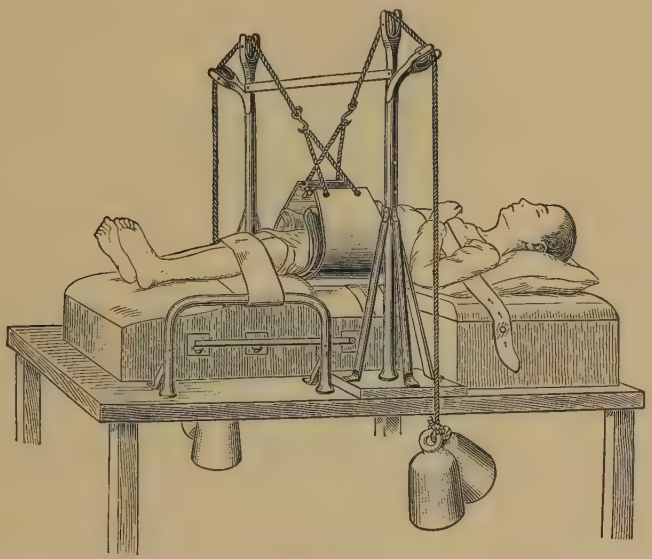
Closure of the neck of the bladder (fistula), the bladder and skin being sutured separately.

the deposit of phosphates. In certain instances shrinking of the flap has produced pressure upon the mouth of the ureter and interfered with the flow of urine; thus at its best, closure of the vesical defect by means of flaps falls far short of restoring the parts to a normal condition.

Attempts have been made to restore the anatomical relations of the cleft bladder by union of the divided edges. Such an attempt was made by Gerody in 1845. He simply freshened the edges and stitched them together, but on account of the great tension the sutures cut through and the defect was reproduced. In 1883 Czerny loosened the bladder from its attachments except for a small area at its base and around the urethral opening, and then stitched the free edges of the bladder together longitudinally by Lembert sutures.

The bladder was then completely lined with mucous membrane, but was so small that it was of little consequence as a receptacle. In 1890 Segond separated the mucous membrane of the bladder in a similar manner and stitched it to the freshened edges of the urethra, less with the intention to form a new bladder than to guide the urine out through the urethral curve. (Figs. 165, 166, and 167.) But he and others who followed him achieved several favorable results. They had also many failures, either on account of gangrene of the mucous membrane or on account of cutting out of the sutures.

FIG. 171.



Trendelenburg's apparatus for keeping the pubic bones in contact after sacroiliac symphysiotomy for exstrophy of bladder combined with a splitting of the pelvic girdle. (Hartmann.)

These cases have, however, failed to prove that calculi will not form if the urine comes into contact after operation with surfaces lined only with mucous membrane. Tietze's method of operating is shown in Figs. 168, 169, and 170.

The methods thus far described were intended to re-establish the vesical cavity. Operators have also attempted to bring the separated bones together either by apparatus (Passavant) or by operation (Trendelenburg). The latter divided both sacral synchondroses. He then fastened a leather girdle around the pelvis, whose ends crossed in front and were pulled down by weights in order to press together the portions of the pelvis which had been loosened from the sacrum. (Fig. 171.) After some weeks the pelvic bones were fixed in the new position and the cleft in the symphysis was closed. The cleft in the bladder was then freshened and sutured.

(Figs. 172, 173, and 174.) The urethra was restored by freeing its edge from both sides and suturing them over a catheter. Trendelenburg operated upon five patients, two of whom did not survive the operation. In the three who recovered small fistulas persisted. In one patient the fistula was finally closed, and he had a certain degree of urinary continence, but suffered from cystitis and incrustation. In still another case of vesical cleft Trendelenburg found that the mucous membrane was too limited for the purpose of making a vesical cavity, and he was obliged to resort to artificial flaps.

Fig. 172.

Operation by direct suture for exstrophy of the bladder. (Trendelenburg.)

Most surgeons have looked upon division of the sacroiliac synchondroses as too serious and too uncertain an operation to be tried in these cases. They have sought to overcome the separation of the cleft symphysis in other ways. Thus in 1891 Hoffmann was able to bring the bony margins together and fix them by suture. Schlange separated the recti muscles from the underlying fascia and chiselled off their attachments to the pubic bones. The edges of the cleft could then be sutured without undue tension. The urethra had previously been restored, but there was left a fistula at the junction of the bladder and urethra, and there was no continence. Mikulicz

operated in a similar manner, except that he did not attempt to close the bladder until the wounds caused by the first part of the operation had granulated. Seven patients were operated upon. In two cases the operation was a complete failure. In one the development of severe cystitis and pyonephritis made it impossible to attempt the closure of the neck of the bladder. In the remaining cases closure was complete or only fine fistulas remained. Continence was in no case obtained. Other operators have made attempts to secure an osteoplastic closure, but without notable result. Thus it is seen that continence of urine has never been obtained by these methods of

FIG. 173.

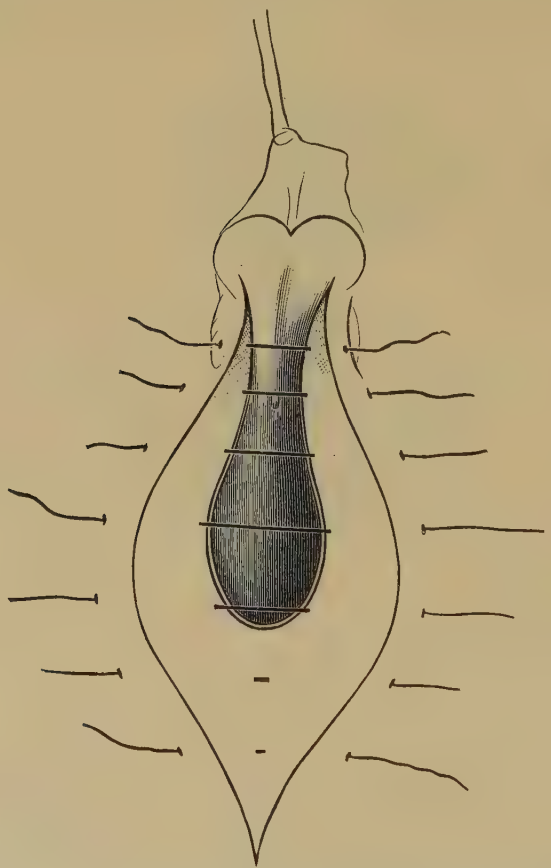
Operation by direct suture for exstrophy of the bladder. (Trendelenburg.)

operation; and further, that a vesical space, even though it is lined with vesical mucous membrane, differs materially from a normal bladder entirely apart from the fact that it is apt to be associated with fistula of the most obstinate character. In spite of the mucous lining, incrustation may develop in the new-formed bladder.

DEVIATION OF THE URINARY STREAM.—Methods of operation have been devised to improve the condition of the patient with cleft of the bladder by diverting the stream of urine into other channels. Sonnenburg's method consists in complete extirpation of the bladder, plastic closure of the defect, separation of the ureters and their suture in the upper portion of the urethral gutter. If this attempt suc-

ceeds, the patient will be able to collect his urine comfortably in a urinal, which can be emptied from time to time. This method of operation surpassed those previously practised in simplicity and rapidity of healing; even it failed in providing a vesical cavity. Sonnenburg first operated by this method in 1881 on a nine-year old boy in whom the prominence of the everted bladder made a flap operation impossible, and the wearing of a urinal unsatisfactory.

Fig. 174.

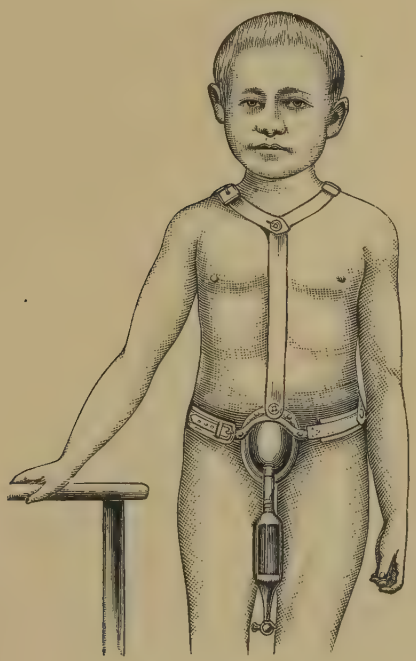


Operation by direct suture for exstrophy of the bladder. (Trendelenburg.)

The bladder was freed and removed without opening the peritoneal cavity. The ureters were loosened for a short distance and stitched in the beginning of the urethral gutter. Healing was perfect. The defect in the abdominal wall was closed by lateral flaps, which were separated below and brought to the median line. On account of the size of the defect its whole area could not be covered in and a

part of it healed by granulation. The wound was entirely closed in two months. A simple urinal could then be worn without difficulty on account of the favorable situation of the ureters. (See Fig. 175.) By this operation the patient was freed from the severe pains caused by ulceration of the prolapsed mucous membrane, and freed from the risk of inflammatory processes extending to the kidneys. He was also enabled by his apparatus to learn a trade and become a useful member of society. Eighteen years after the operation he was employed as a nurse in one of the Berlin hospitals. His condition did not in the least affect his growth nor interfere with his duties. The apparatus fitted so well that no urine escaped either

Fig. 175.



during the day or at night. In the site of the extirpated bladder there was a depression in whose deepest portion the urethral mouths were situated at the insertion of the urethral groove. A firm scar occupied the position previously held by the everted bladder. (Fig. 176.) Other individuals operated upon by Sonnenburg by the same method have done equally well, and other surgeons have also reported successes with it. (Zesas, Niehaus, and Ahn.) Iterson operated by the same method upon a two-year-old girl with good effect. He sutured the loosened ureters to the labia minora and sewed them together in the median line. Estor operated with suc-

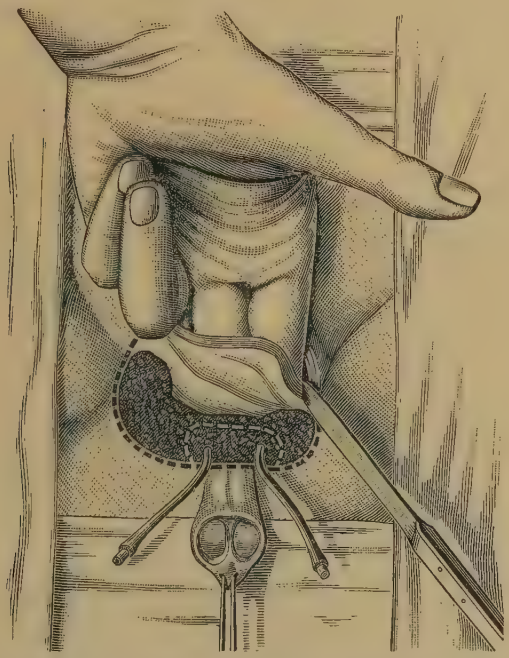
cess upon a child thirteen months old. In 1889 Segond attempted to improve upon Sonnenburg's method by utilizing the mucous membrane of the bladder as a flap to cover in the urethral gutter. The long, apron-like prepuce was slit at its base, the head of the penis was pushed through, and the prepuce was stitched to the flap of the mucous membrane of the bladder. The urethra was thus completed. The wound in the abdomen was closed by lateral flaps.

FIG. 176.

Simon diverted the urine into the rectum, basing the operation upon the fact that in many animals there is a cloaca that serves as a common receptacle for urine and feces; and that, further, the ureters are sometimes found at birth to open into the rectum; and still fur-

ther, that patients with a fistula between the bladder and the rectum learn in time to control more or less the escape of urine from the anus. His patient and one operated upon by Lloyd died of peritonitis. Thiersch was the first to establish permanent connection between the bladder and rectum in 1881. In the next ten years numerous experiments upon animals seemed to show that the mucous membrane of the rectum was capable of withstanding the constant

FIG. 177.



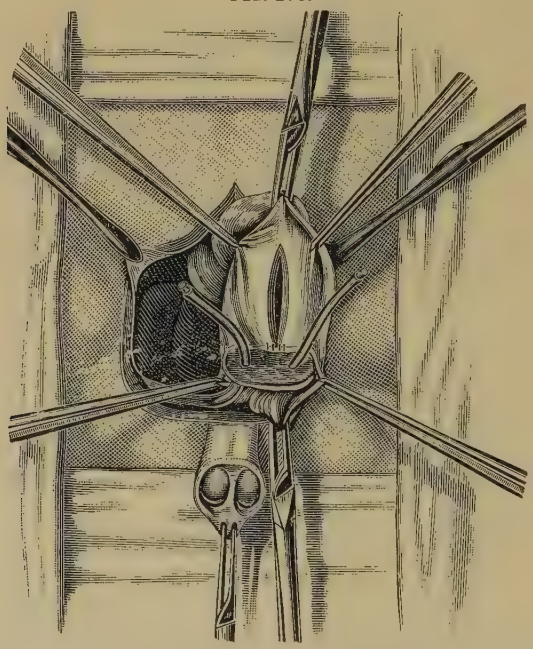
Maydl's operation for bladder exstrophy, consisting of transplantation of the bladder-wall with the ureteral openings into the sigmoid flexure. (Hartmann.)

irritation of urine, and that the sphincter of the rectum would prevent its escape more or less perfectly. But the fear of ureteritis and ascending pyonephrosis kept surgeons from repeating Simon's operation until 1892. In that year Maydl incised the everted mucous membrane of a man aged twenty, and after opening the peritoneal cavity implanted in the sigmoid flexure an elliptical piece of the base of the bladder containing the mouths of the ureters. He hoped to avoid infection in the ureters by preserving intact their mouths with their sphincters, and also by implanting them in a portion of the intestine which is free from fluid and does not constantly contain fecal matter. (Figs. 177, 178, and 179.) This patient recovered from the operation and passed urine every four to eight hours. Since that time some twenty cases have been reported by different

operators. Although the risk of secondary infection is much lessened by careful attention to the principles laid down by Maydl, it nevertheless exists, as shown by a death occurring from pyelitis fifteen months after operation. Park lost a patient from obstruction to the passage of urine due to kinking of the ureters.

Gersuny's modification of Maydl's operation is as follows: The rectum is separated from the sigmoid flexure by a transverse incision. The ureters, with a portion of the wall of the bladder, are implanted in the rectum, the opening into which is exactly sutured in order to convert it into a sort of bladder. The cut end of the sigmoid is brought down below Douglas's pouch and inserted in the rectum just above the sphincter.

FIG. 178.



Maydl's operation for bladder exstrophy, consisting of transplantation of the bladder-wall with the ureteral openings into the sigmoid flexure. (Hartmann.)

Hochenegg implanted the ureters in a loop of small intestine. Rutkowski separated a loop of ileum and utilized it for the interior wall of the bladder, joining together the cut ends of the small intestine so as not to interfere with the continuity of the canal. Mikulicz has also operated in this manner with success.

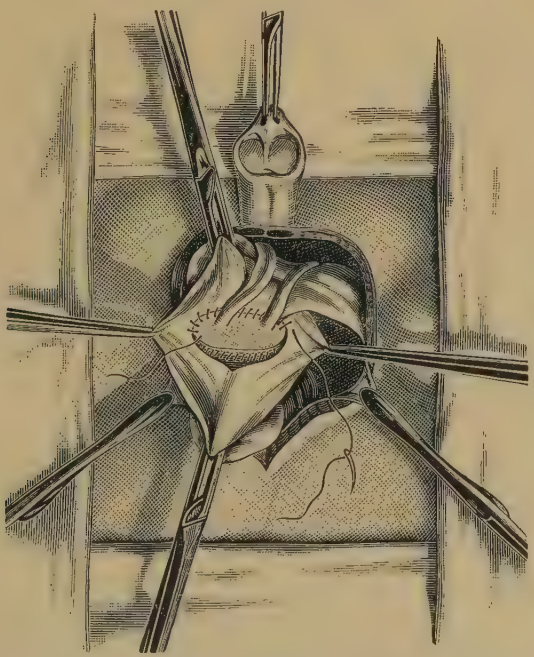
In conclusion it may be stated:

1. That the attempt to form a new bladder by the various plastic methods is of little value because continence is never obtained. The vesical space will always be insufficient on account of the forward

pressure of the posterior bladder-wall when the patient stands. If the patient lies down, there may be, properly speaking, a bladder cavity. Union of the edges of the bladder without a plastic operation to supply an anterior wall does not create a sufficient vesical space, and is also certain to be followed by incontinence. Patients operated upon by this method as well as by the plastic method suffer from the development of calculi and from incrustation and inflammation in the new-formed cavity. These patients are compelled to wear a urinal.

2. Removal of the bladder and suture of the ureters in the urethral gutter is an operation which is simple and without danger, and it is followed by a short period of recovery. It frees the patient from his pain and allows him to wear a comfortable urinal.

FIG. 179.



Maydl's operation for bladder exstrophy, consisting of transplantation of the bladder-wall with the ureteral openings into the sigmoid flexure. (Hartmann.)

3. Implantation of the ureters in the intestine is a hazardous operation. It is accompanied by considerable risk, and time must show whether the rectum will tolerate the presence of urine for long periods of time, whether the anus will be able to give permanent control, and whether operation will be followed by nephritis.

It is comparatively easy to restore the urethra and the penis, but this is of little value as long as incontinence persists. The urethra is formed by making longitudinal incisions on both sides of the

mucous membrane, cutting under the mucous membrane on one side and suturing the two edges by catgut stitches, the knots of which lie within the canal. The wound-surfaces of the corpora cavernosa or of the labia are sutured with silver wire. A drain is passed through the urethra thus formed into the open neck of the bladder. In order afterward to close the neck of the bladder the fistula which exists is freed by an oval incision and its edges are turned in and sutured with catgut. The skin is then sutured over the raw surface and a drain is passed through the urethra into the bladder. The lateral sutures should be inserted deeply in the tissues in order to narrow the neck of the bladder in the hope of obtaining an elastic closure.

DOUBLE BLADDER.

If the partitions between the two halves of the allantois fails, a double bladder will be the result. A single ureter will open in each bladder. Usually this abnormality is associated with others of so grave a nature that the infant cannot live. The condition, however, has been met with in the adult. A divided bladder with a complete or incomplete partition has been frequently described. There may also be a diverticulum in connection with this condition. Hofmokl has described such a diverticulum in a woman, and which gave no trouble until as the result of cystitis it became infected and filled with pus. It communicated with the bladder through a narrow passage and appeared to be of congenital origin. The treatment of such a diverticulum should be excision. The cystoscope might be useful in clearing up a doubtful diagnosis.

CHAPTER XXIII.

INJURIES OF THE BLADDER.

Injuries of the bladder are more likely to occur when the organ is distended with fluid, since it then rises above the symphysis pubis and its anterior wall becomes more exposed. The bladder is frequently injured when the pelvis is fractured. No reference will here be made to injuries of the bladder brought about by catheters, sounds, lithotrites, or other instruments, or to the injuries of the bladder received during labor. Traumatic injuries of the bladder may involve the whole thickness of the wall or only a part of it. Injuries of the latter character are of less importance, while those which involve the whole thickness of the bladder-wall are so important as seriously to threaten life.

RUPTURE OF THE BLADDER.

Rupture of the bladder is an accident which affects chiefly men: 90 per cent. of 100 cases occurred in the male sex, and most of them in adult life. Rupture may occur in conjunction with fracture of the pelvis, or without this if the bladder is fully distended. It then reaches well above the symphysis pubis and is exposed to injury; while if the distended bladder is caught between the anterior abdominal wall and the posterior brim of the pelvis, it is easy to understand how it may be ruptured. There are a few rather indefinite records of rupture of the bladder occurring in other ways, as, for example, by a fall upon the feet or upon the sacral region.

Bartels gives three possible causes of rupture of the bladder:

1. A blow of a hard object received in the region of the bladder; for example, a blow of a fist or a kick of a horse, a fall, etc.

2. A fall from a height by which the patient is thrown prone upon the ground.

3. A direct injury produced by the pressure of some heavy object upon the pelvis, as, for example, the passage of a cart-wheel, or catching of the patient between the buffers of two freight cars.

In the second and third classes of injury rupture of the bladder is often associated with fracture of the pelvis. Antal adds a fourth class in which rupture of the bladder is the result solely of excessive artificial distention. Cases due to this cause, if they occur, must be extremely rare, so that one is scarcely justified in making a separate

class for them. According to Guyon, who attributes such rupture to a hypertrophy of the muscles of the bladder, the artificial distention of the organ causes these hypertrophied muscles to contract, which they may do with such force as to burst the bladder. Dittel states that if the bladder of a cadaver is distended with air until it bursts, the rent will almost invariably occur in the posterior wall intraperitoneally. If, however, the distention be made with water, the rent will occur intraperitoneally in about one-half of the cases, and extraperitoneally in the other half. Of eight cases of rupture of the bladder which occurred in actual practice from overdistention, the rent was extraperitoneally seven times and intraperitoneally only once.

The degree of distention of the bladder plays an important part in the rupture of the organ, though if the bones of the pelvis are broken some sharp fragment may puncture even the empty collapsed bladder. Acute alcoholism is said to lessen the elastic tone of the organ, and so may act as a predisposing cause of perforation. It is more likely, however, that individuals in a condition of alcoholism allow their bladders to become overdistended and thus expose them to injury. Natural pathological changes in the bladder may predispose to rupture of the organ.

The site at which the bladder ruptures varies. Intraperitoneal rupture is said to occur most frequently at the summit of the bladder or in the posterior wall, while extraperitoneal rupture occurs most frequently in the anterior wall. The ruptures vary in character and in extent. Usually they are linear, although they may be zigzag or of an irregular shape. They may extend from above downward or from side to side. In the latter case the edges of the wound gap very little. The tear may measure anywhere from 1 to 12 cm. (0.4 to 4.8 inches). Generally it does not exceed 5 cm. (2 inches) in length, and it often looks more like a perforation than a tear.

If the rent is wholly intraperitoneal and situated in the posterior wall, the urine is discharged at once into the peritoneal cavity and sets up a septic peritonitis. At autopsy the collection of fluid is found to be greatest in the pelvis. If the intraperitoneal rent is not very large, the bladder may not empty itself completely, and the small quantity of urine which escapes into the retrovesical tissue may there be completely encapsulated. But generally, however, such an accident terminates in death. Extraperitoneal ruptures are less frequent. Bartels collected 169 cases of rupture of the bladder, and found only 49 of them to be extraperitoneal. The rent may be found in any portion of the bladder. If the rent occurs posteriorly, the mucosa and muscularis will tear, while the serosa will hold. Such a form of rupture has been called a subperitoneal one. The amount of urine which escapes under such circumstances depends upon the nature of the rent. If this is small, the urine escapes drop by drop and has time to become encap-

PLATE XV.

Extensive Rupture of the Bladder, showing Peritoneal Surface. (Taylor.)

sulated. If the rent is large, the infiltration of urine is extensive, and may bring about necrosis of the loose connective tissue and extend up to the kidneys or down to the knees. It may also involve the peritoneum in a diffuse inflammation.

Bartels found fracture of the pelvis 109 times in 179 cases of rupture of the bladder. The os pubes shared in the fracture 27 times, the ischium 12 times, the ilium 9 times, and the sacrum together with the pubes 5 times. In 22 cases the symphysis pubis was loosened, while the sacroiliac synchondrosis was loosened in 10 cases. The seat of the fracture was not determined in 11 cases, while the fracture was multiple in 30 cases.

Rupture of the bladder is the most threatening injury which may happen to the urinary system, but it is not the most common. Fracture of the pelvis may be associated with rupture of the kidney, of the bladder, or of the urethra.

Symptoms.—The first symptom noted after rupture of the bladder is that of shock, which may be so severe that consciousness is lost, or the shock may even terminate in speedy death. This not infrequently happens if the person injured is intoxicated. If the symptoms of shock grow less marked, the patient complains of intense desire to urinate without being able to pass any water. Even with the greatest effort he is able to pass only a few drops of blood or bloody urine from the urethra. This symptom is so constant that only in rare instances is the passage of urine free. There is also intense pain in the region of the bladder extending possibly over the whole lower portion of the abdomen. Frequently there are nausea and vomiting and the early symptoms of acute peritonitis. Sometimes after a short interval a well-defined, tense, painful swelling can be made out. If the urethra is uninjured and did not contain any obstruction before the accident, a catheter readily passes to the bladder. The bladder is found empty, so that only a few drops of bloody urine will escape by the catheter. The bladder is collapsed, and therefore as the catheter passes into it it appears to strike against an obstruction. If the catheter is moved about from side to side, it may suddenly enter a larger cavity, in which it may be passed for quite a distance or moved about laterally. As soon as it enters this larger space a great quantity of clear urine or urine mixed with blood and blood-clots may be evacuated. These facts are easily explained. The beak of the instrument has passed through the rent in the bladder into the abdominal cavity, or into the connective tissue about the bladder in which the urine and blood collected after the rupture of the bladder. Such a collection of fluid may exist without its presence having been evident upon palpation or percussion.

The symptoms which follow rupture of the bladder due to artificial overdistention are characteristic. The resistance which the injected fluid has to overcome suddenly lessens and the round tumor above the symphysis pubis formed by the gradually distending

bladder at once disappears. Only a small quantity of fluid can be obtained by a catheter.

It is stated above that fracture of the pelvis may be associated with rupture of the urethra or bladder or kidney. The urine may contain blood in whichever situation rupture occurs. The amount of blood need not be great, and it is impossible to judge the extent of the injury from the amount of hemorrhage, especially since torn wounds bleed far less than incised wounds. If a catheter is easily passed and the mixture of blood and urine is evacuated from the bladder, it is probable that the kidney is ruptured. Such urine is bright red and contains no blood-clots. It should be examined at once in order to determine the presence of red blood-corpuscles. If the catheter passes into the bladder without difficulty, but brings away no urine, or only a few drops of bloody urine, there is probably rupture of the bladder. Furthermore, if the bladder is ruptured, pressure in the lumbar region will not be so painful as it will be if the kidney is ruptured. If blood flows spontaneously from the meatus, the urethra is probably ruptured. In uncomplicated cases of this character there will be absolute retention of urine, and it will not be possible to pass a catheter into the bladder.

Diagnosis may be more difficult on account of the absence of pain and swelling for a little time after the accident. This is also true of other intra-abdominal ruptures. If there is an intraperitoneal rupture of the bladder, the urine flows at once into the peritoneal cavity and apparently may be quickly resorbed—at least there have been cases of intraperitoneal rupture of the bladder in which at autopsy no urine was found in the peritoneal cavity and no sign of peritoneal irritation. It is possible that in such cases the patient was carried off by a rapid form of sepsis before the peritoneum had time to show any changes.

As more time elapses degenerative changes and suppuration take place in the abdominal cavity. The urine constantly accumulates, and as the pressure increases it is forced between the layers of the bladder into the connective tissue. On the second or third day the patient will exhibit the symptoms of gangrenous peritonitis, infiltration of urine, and uræmia. If the rupture is an intraperitoneal one, it is followed immediately by acute peritonitis. If the rupture is extraperitoneal, the symptoms of infiltration of urine develop. Such an infiltration is not composed of pure urine, but of urine mixed with blood.

Diagnosis.—It is not always possible to make an absolute diagnosis of rupture of the bladder when the patient is first seen. The intense desire to urinate and the inability to do so are very suggestive symptoms, but there have been cases of rupture of the bladder in which the symptoms of shock were absent and the patient was able to pass urine voluntarily. This may have been due to the fact that the rupture of the bladder was at first incomplete, and did not until

later involve the whole thickness of the bladder-wall. Rose says that even if the catheter pass up as far as the liver, and even if its beak can be felt through the abdominal wall, the diagnosis of rupture of the bladder cannot be absolutely made since there are instances, at least in older children, in which retention of urine has distended the bladder up to the umbilicus or even up to the liver. Under such circumstances the walls of the bladder and of the abdomen are so thin that the beak of the catheter is more plainly felt through them than it is through a normal abdominal wall after the catheter has passed through a rent in the bladder. Hence before the diagnosis is made other symptoms must be observed.

It is still more difficult to determine immediately after the injury whether a rupture of the bladder is an intraperitoneal or an extraperitoneal one. The difference between these two conditions is not well marked until after a lapse of some days; then acute peritonitis on the one hand or excessive infiltration of urine on the other will indicate whether the rupture involves the peritoneal cavity or not. With the cystoscope it may be possible to differentiate the two conditions, but the collapse of the bladder interferes with the proper use of this instrument. The following case will show how difficult it is at times to determine the site of an injury of the urinary passages: The wheels of a horse-car passed across the left thigh and lower portion of the abdomen of a boy, producing a fracture of the pubes. The patient presented the symptoms of shock and of peritonitis (vomiting, etc.). Within twelve hours after the accident he twice passed spontaneously 30 grammes (1 ounce) of dark bloody urine. This act was painful. Blood trickled more or less constantly from the meatus. An area of dulness gradually developed above the symphysis, especially to the left of the median line, while the symptoms of peritonitis increased and there was absolute retention of urine. The diagnosis lay between rupture of the kidney, rupture of the bladder, and rupture of the urethra. The boy was chloroformed and the catheter was passed into the bladder. It drew off at once pure blood and then about 60 grammes (2 ounces) of clotted fluid. A silver catheter could be passed for a long distance. Pressure upon the left side of the abdomen caused still more fluid to flow out, and the surgeon had the feeling that the catheter had not entered the bladder. The injury was thought to be either a rupture of the urethra or a rupture low down in the bladder. The pelvis was elevated and the abdomen opened. The peritoneum appeared dark red, mushy, and pushed forward. A great quantity of urine mixed with blood escaped from beneath the symphysis. The bladder was opened, but no rent in it could be found. The finger was passed down between the bladder and the symphysis and entered a large cavity. The case was one of rupture of the urethra close to the bladder. External urethrotomy was performed and the patient recovered. It was evident that the catheter had not entered the bladder, but had

passed into the cavity referred to, hence urine escaped through the catheter chiefly when pressure was made externally. It is doubtful whether the urine which was voluntarily evacuated came from the bladder.

Treatment.—Mortality after rupture of the bladder was previously very high because operative measures were delayed. Thus, according to Ullmann's statistics there were only 22 recoveries in 237 cases of rupture of the bladder. In 143 cases of intraperitoneal rupture there were 2 recoveries, while in 94 cases of extraperitoneal rupture there were 20 recoveries. If fracture of the pelvis exists with rupture of the bladder, the prognosis is worse than when the rupture is the only injury. To-day, when operation is much more frequently performed within a short time after the accident, prognosis is considerably better. As soon as the diagnosis is made, the only rational treatment is a surgical one, which has to meet the two dangers of peritonitis and infiltration of the urine.

It is useless to discuss the question whether pure urine can or cannot cause inflammation of the peritoneum. Even if it cannot do so, infection will be induced by catheterization, for every patient who is seen suffering from rupture of the bladder and making fruitless attempts to pass urine will be at once subjected to catheterization. The idea of treating such a patient by either a temporary or permanent use of the catheter should not be entertained. Laparotomy is the only treatment which is at all adapted to meet the conditions. The incision should be made in the middle line and the bladder looked for. If the diagnosis of rupture of the bladder is either a certain or a probable one, the surgeon should explore the connective tissue above the symphysis before opening the peritoneal cavity, for it may be that an extraperitoneal rupture exists. If a catheter is passed through the urethra into the bladder, it will materially aid in the search for the rent. If this is found, the surgeon should pass his finger through it into the bladder in order to make sure that there is not a second rupture—perhaps an intraperitoneal one. If the rupture is single, there are two courses of treatment which may be followed: either a drainage-tube may be passed above the symphysis through the wound into the bladder, or the wound in the bladder may be sutured. The latter method is better adapted to cases in which operation is performed within a short time after the accident. If the rent in the bladder is situated more at the side and is thus reached with difficulty, the incision through the soft parts must be extended laterally in order fully to expose the vesical wound. If from the situation and appearance of the rent in the bladder the surgeon decides to suture it, he should tampon the space in front of or at the side of the bladder with iodoform gauze and leave the abdominal wound open. Then if the vesical suture leaks, the connective-tissue space about the bladder will not become distended with urine and adhesions will form which will prevent subsequent infection.

If exploration of the space in front of the bladder does not reveal a rupture and there is no sign of extravasation of urine, the bladder should be opened extraperitoneally and the surgeon's finger passed into its cavity. This precaution should be taken for the reason that the rent may still be extraperitoneal, and the abdominal cavity may thus be protected from an unnecessary incision. In such a case the peritoneal reflection upon the bladder should be peeled off until the rupture is reached. This should be sutured and the wound drained with gauze. If the surgeon's finger passed into the bladder finds a rent into the peritoneal cavity, the incision should be prolonged so as to open this cavity and the bloody urine and clots should be carefully removed. If the pelvis of the patient is then elevated, the intestines will fall upward toward the diaphragm, and the surgeon will not only be able to determine the extent of the injury, but will also be enabled in many cases to close it by suture. Some surgeons will then suture the peritoneal cavity, but a safer method of procedure is extensive tamponade. The incision made in the anterior wall of the bladder is next to be sutured. A catheter should be passed frequently to prevent the accumulation in the bladder of a considerable quantity of urine. If the presence of urine in the peritoneal cavity or commencing peritonitis shows clearly that the bladder has ruptured intraperitoneally, the surgeon may prefer to open at once the peritoneal cavity in order to find and suture the vesical wound.

The oldest recorded case of cure of an intraperitoneal rupture of the bladder is that of Walter, of Pittsburg, in 1863. He operated upon a man aged twenty-two years ten hours after a blow upon the abdomen. The symptoms were abdominal distention, vomiting, a desire to urinate but inability to do so, while a very small quantity of urine was obtained by the catheter. Walter found at operation a two-inch rupture in the fundus of the bladder. The bladder was not sutured, but a catheter was passed into it through the urethra and left in position. The abdominal wound was sutured one week later. The patient was able to pass water voluntarily after three weeks.

In 1862 MacCormac operated upon a man aged thirty-three, nineteen hours after his bladder had been ruptured by a fall against a picket. The rent in the bladder was closed by a double row of sutures, a glass drain was placed in Douglas's pouch, and a catheter left in the bladder. The abdominal cavity was washed out with a 1 ‰ per cent. solution of boric acid and the wound closed. The patient recovered in three weeks.

Rose reports a case of rupture of the bladder with fracture of the pelvis, caused by a wagon-wheel, in which he opened the abdomen forty-eight hours after the accident. The abdominal cavity contained a great deal of bloody and purulent fluid. Neither the wound in the bladder nor the abdominal wound was sutured, and so

much fluid escaped through the wound that it was unnecessary to leave a catheter in the urethra. In spite of this serious condition the patient was able in fourteen days to pass urine voluntarily, and in two months he had entirely recovered. This is perhaps the longest period which has elapsed between the accident and a successful operation.

Another case mentioned by Rose illustrates extraperitoneal rupture of the bladder. A man aged thirty-two fell three stories, and striking on a pavement sustained a fracture of the pelvis. The patient was unable to pass water, and only a little bloody fluid could be obtained by catheter. There were no symptoms of shock nor any external evidences of infiltration of urine. On the following day an incision was made above the symphysis, and the space of Retzius was found full of urine. Moreover, the bladder was distended with urine. There was a longitudinal rupture of the bladder about five inches long, which reached into the abdominal portion of the organ, but did not open the peritoneal cavity. The peritoneum had been peeled off to some extent by the force of the accumulated urine. The wounded bladder was sutured and the external wound was drained. No dressing was applied, the patient being placed for several hours each day in a bath. A urinary fistula remained which was successfully closed by a second operation.

INJURIES OF THE BLADDER ASSOCIATED WITH EXTERNAL INJURIES.

It rarely happens that the bladder is opened by a stab or a shot, because it is placed in such a protected situation. The distended bladder is more exposed to this kind of injury than the empty bladder. It is important to remember that as the bladder distends the peritoneal reflection on its anterior surface rises higher and higher, while that of the posterior wall does not change its position on account of its close attachment to the prostatic fascia.

In punctured wounds of the bladder the instrument usually enters it above the symphysis, rarely through the perineum. In one case mentioned the instrument reached the bladder through the obturator foramen. Such objects as sticks, tines of hayforks, and the horns of cattle are more often the cause of rupture than sharper weapons, such as knives, daggers, and swords. If the perforation occurs through the perineum, it is usually the result of a fall upon a picket or other sharp object. When this occurs, the rectum is frequently injured so that a communication exists between this cavity and that of the bladder. If the patient is a woman, the vagina may be punctured at the same time, as in the celebrated case mentioned by Jobert, of a woman who fell from a horse, and whose vagina and bladder were perforated by a lead-pencil in the pocket of her dress. Gunshot-wounds may occur in

any portion of the bladder. They are usually associated with injuries of the bone or of other pelvic organs. Bartels collected 504 cases of injury and rupture of the bladder, among them being 285 cases of gunshot-wounds of the bladder. In 136 of these cases there were present both a wound of entrance and one of exit. The bladder may be injured indirectly by a gunshot-wound, the bullet tearing off some splinters of bone which puncture the bladder. Coexisting injury of the peritoneum is a complication of grave import.

Diagnosis.—A perforating wound of the bladder gives the same symptoms as a rupture. A patient who has been injured in this manner falls and is unable to rise. He complains of intense pain in the lower part of the abdomen and in the loin, the pain extending into the thighs. His countenance is much drawn. There is intense vesical and rectal tenesmus. If the abdomen is injured, there will be additional symptoms of a well-known character, but the typical symptom of this injury is the escape of more or less bloody urine from the wound. This symptom is almost always present. It may fail if the urine which escapes from the bladder is lost in the loose connective tissue before it reaches the skin. Such is more likely to be the case if the wound in the skin is extremely small. If the wound in the skin is large and the bladder at the time of accident was distended, urine may flow in a stream from the wound. After a gunshot-wound the escape of bloody urine may not be noticed for a day or more; or, if it is present, it may cease on account of the adhesions of the walls of the wound. In other cases a urinary fistula persists and continues to discharge urine drop by drop. Aside from these symptoms the patient's condition will be exactly that of a patient with rupture of the bladder until he shows plainly the evidences of general peritonitis or general infiltration of urine. It is to be noted, however, that punctured wounds, whether caused by a sharp instrument or a bullet, may heal of themselves if they are extraperitoneal. This happy outcome is due to the fact that the wound allows the urine which escapes from the bladder more or less free drainage, thereby avoiding urinary infiltration of the tissues. If the punctured wound enters the bladder from the perineum or from the rectum, the conditions for drainage are even better, since the bladder is opened in its lowest part and the wound is shorter than wounds which enter the bladder from other directions. It may also happen that a stab-wound or a gunshot-wound of the bladder will close, but will open again after a few days, and thus expose the patient a second time to infiltration of urine and sepsis. If the wound is turned into a urinary fistula, the process of recovery is tedious, and the fistula is apt to open after it has healed. According to Bartels, if there are two openings, the posterior one usually closes before the anterior one. If a foreign body is introduced into the bladder as a result of injury, a calculus is likely to form about it.

Treatment.—If there is the slightest sign of peritonitis, laparotomy should be performed exactly as in cases of rupture of the bladder. Even if there is no suspicion of peritonitis, it is good practice to open the prevesical connective tissue and to tampon the wound. If the injury of the bladder is found, it should be treated in accordance with the rules given in the preceding pages. The introduction of an aseptic catheter, while it carries with it little risk, will also be of little benefit. Under certain circumstances the harmful effects of distention may be lessened, but the risk of urinary infiltration cannot be avoided by such means. The proper treatment in accordance with modern surgical ideas is to make a suprapubic incision, to expose the prevesical space, and, if necessary, to open the peritoneal cavity.

The bladder has frequently been injured in the removal of tumors. Sonnenburg reports a case in which a portion of the bladder-wall was removed with an ovarian cystosarcoma, which was adherent not only to the bladder, but also to the uterus, intestine, and anterior peritoneal wall. The portion of the bladder which was lost in this manner was so considerable that the operator did not think it wise to suture the remaining portion. Both ureters were uninjured; the remains of the bladder were stitched in the abdominal wound, which gradually closed more and more until six months later the anterior wall of the bladder was made of flaps of skin and the bladder was closed as in the operation for vesical cleft. The patient was able to retain urine for one or two hours.

URINARY FISTULAS FOLLOWING INJURIES OF THE BLADDER.

A fistula may develop between the bladder and vagina as a result of a difficult labor. Such fistulas have received different names according to their position; thus there are vesicovaginal fistulas; vesico-uterovaginal fistulas, which may be either superficial or deep; vesico-uterine fistulas, which open into the cervix uteri; vesicorectal fistulas, in which a communication exists between the bladder and the rectum. A fistula may also exist between the small intestine and the bladder. Such a fistula is called an enterovesical fistula. There may, of course, be combinations of these different types.

Fistulas arising from a difficult labor may have different causes. They may come from the pressure of the head of the child or from the use of instruments. A catheter used during labor with too great force has been known to produce a vesicovaginal fistula. Fistulas between the bladder and vagina are usually situated a little to one side of the median line and in the lower third of the vagina, when they are the result of operations performed during labor.

Symptoms.—If from any cause there is a communication between the bladder and the vagina, the urine flows at once through the vagina and vulva. Involuntary flow of urine is therefore the first

and most important symptom. The fistula is often difficult to find on account of cicatricial contraction. Simon determines the size of the fistula by dilating the urethra and palpating the lining of the bladder with the index finger. When the exact site of the fistula is ascertained, the character of its edges should be noted in order to determine the best direction for suture and the amount of tension which will be likely to exist. One should also note the relation of the fistula to the uterus, and whether one or more fistulas are present. Such investigation is sometimes best carried out with the patient on the back, sometimes in the knee-elbow position, and sometimes on the side. It is sometimes necessary to place the patient in different positions in order to expose all the relations of the fistula.

Treatment.—It is the custom at present to operate upon a vesico-vaginal fistula. Such an operation may be performed in the first weeks after labor. The patient should be placed in the position best suited to expose the fistula. When this has been done, its edges are to be freshened. The incision for this purpose should be everywhere an equal distance from the margin of the fistula. The hemorrhage which follows is insignificant unless the vesico-uterine artery is wounded. If the fistula is not very small and is situated well to one side, a ureter may be injured during operation. This accident will be followed by a flow of urine from a small opening into which a probe will pass upward and downward. If the ureter appears as a small string in the fistula, it can be pushed out of the way toward the bladder. If the operator suspects that the fistula is situated close to the ureter, it is a good plan to pass through the bladder into the ureter an elastic catheter or a probe which shall remain there during operation. If the ureter is opened, it must be freed and brought into the bladder and stitched there.

Before inserting the sutures the operator should be sure that the wounded surfaces are everywhere smooth, and that the fistula has been freshened at every point. There are different opinions as to the best suture material. Silver wire or wire made of aluminum bronze is perhaps more used than any other material. Wire has an especial advantage if the stitches must remain a considerable time. The risk of incrustation is no greater when wire is used than when silk is used. Suitable curved needles and long needle-holders are a necessity. The suture should be inserted so as to close the fistula in its longest diameter. When the suture-line is completed, the bladder should be emptied with a catheter and filled with any indifferent fluid in order to test the suture-line. The after-treatment is simple. The patient passes urine as often as she desires to do so. The suture may be removed in a week.

In case of a superficial vesico-uterovaginal fistula the anterior lip of the cervix is freshened and stitched to the freshened margin of the fistula in the bladder and vagina. In the case of deep vesico-uterovaginal fistula the posterior lip of the cervix is utilized to close

the defect. Such a patient will remain sterile. It is often possible even when the remnant of the anterior cervical lip is small to close the fistula by a suture in the longitudinal direction. Vesico-uterine fistulas exhibit a tendency to heal spontaneously. They may be further stimulated by strong caustics. If this plan fails, the cervix should be divided laterally, and the anterior lip drawn down until the fistula can be exposed, freshened, and sutured.

If a vesicovaginal fistula is of great size, it may be closed in a period of one or two months by repeated operations. If the defect is too great for this, or if the margin of the fistula is closely attached to the pelvic bones, or if the fistula is situated so close to the peritoneum that it is not possible to freshen it on all sides, it may be closed by a transverse division of the vagina below the fistula, followed by transverse suture. In other cases in which the defect of tissue has been very great, operators have attempted to improve the condition of the patient by implanting the ureters in the rectum. Another plan is to establish a wide rectovaginal fistula and afterward to close both the urethra and vagina, or the whole vulva.

If communication exists between the bladder and abdominal organs above the pelvis, an extensive laparotomy will be necessary to effect a cure.

Trendelenburg has recently suggested suture of a vesicovaginal fistula from the bladder. Such a method should be reserved for fistulas which cannot be closed from the vagina. If the fistula, for example, is situated in the median line between the two ureteral openings, it is easily reached, freshened, and sutured through an opening in the bladder made suprapubically. If the fistula is situated higher in the bladder or to one side, or if there is firmly adherent cicatricial tissue, the operator who is working through the suprapubic wound will find it more difficult to determine the relation of the ureter and fistula than if he were operating through the vagina. If it is possible to see the fistula through the vagina, it may be of assistance to carry out the operation alternately through the vagina and through the suprapubic wound, and sutures which are inserted through the suprapubic wound can be easily tied in the vagina. If the fistula cannot be reached from the vagina, the sutures to close it should be of catgut, since they must be knotted within the bladder. When the fistula has been closed, the suprapubic wound in the bladder should also be sutured and the patient treated in accordance with the principles given under the heading, Rupture of the Bladder. When operating in this manner it is a good plan to introduce a ureteral probe if the fistula is situated laterally. The method suggested by Trendelenburg is adapted to certain special cases, but it has not been often employed.

Fistulas into the Intestine.—Fistulas between the bladder and intestine are more likely to follow inflammatory than traumatic conditions. Such a communication may be variously situated, and will

therefore be called either a rectovesical, or colicovesical, or enterovesical fistula. Appendicitis and tuberculosis are two fairly common causes of such fistulas.

Diagnosis is not difficult to make, but it is usually impossible to determine without operation what portion of the intestine is involved and how large the fistula is. An accurate analysis of the urine is therefore important. The urine will show the usual appearance of cystitis, and will also contain cells from plants and from the flesh of animals, etc. If the cells of plants appear in an undigested condition, it is fair to assume that the communication is with the upper portion of the intestinal tract. The intestine may not communicate directly with the bladder, but with the intervening cavity of the old abscess. Prognosis under such circumstances is unfavorable. The patient can only be cured by means of a laparotomy with extensive separation and resection of the diseased tissues. The operator will often find unexpected difficulties in his path. If an abnormal union between the appendix and the bladder is suspected to exist, the appendix and cæcum should be sought for through an inguinal incision. The appendix should be separated at its base and removed. The opening in the bladder may be simply closed by suture or inverted and sutured. If a bit of closely adherent appendix remains attached to the bladder, it may be inverted without danger. It is to be noted in these cases that the cæcum and appendix are situated low down, many times as low as the brim of the pelvis or even in the pelvis.

FOREIGN BODIES IN THE URINARY BLADDER.

A great variety of foreign bodies have been found in the bladder, such as pieces of catheter, pins, pen-holders, thermometers, quills, stones, sealing-wax, etc. Such objects usually enter the bladder through the urethra, into which they are introduced for therapeutic purposes or for sexual excitement. (Fig. 180.) They are found more often in the female bladder on account of the shortness of the female urethra. Soft rubber catheters when old become brittle and pieces may break off and remain in the male bladder. If a piece of catheter or other foreign body enters the urethra, attempts to extract it usually push it deeper until it enters the bladder.

Foreign bodies, such as bullets, splinters, etc., may enter the bladder through wounds of the anterior abdominal wall or parenchyma. In rare cases fragments of bone may enter the bladder when the pelvis is crushed. In other cases foreign bodies ulcerate through from the intestine and make their way with more or less suppuration into the bladder.

After severe operations upon the bladder, sutures and ligatures, even when composed of catgut, may work their way into its cavity. This may also happen to ligatures which are employed outside of the

bladder, for example, in ovariotomy. In case the ligatures are still attached to the vesical wall their presence is easily made out through the cystoscope.

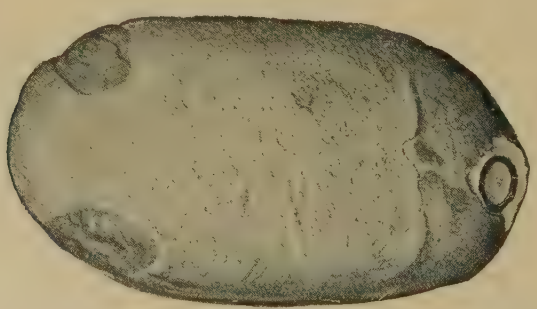
The fate of a foreign object which has entered the bladder depends partly upon its characteristics and partly upon the bladder itself. If the object is small and round like a shot, it can be passed through the urethra without causing serious symptoms. Few objects can remain in the bladder for any length of time without becoming incrusted with urinary salts, usually the phosphates. This incrustation takes place more rapidly in the presence of cystitis and ammoniacal degeneration of the urine. Under such circumstances a very large calculus may form around a foreign body in a short time. Fig. 181 shows such a one which formed around a glass tube within six weeks. In Fig. 182 are shown the fragments of a calculus which developed around a hairpin.

Fig. 180.

Hairpin found in the bladder, partially covered with incrustation. (Wendel.)

Even if there is no catarrh when the foreign body is introduced, its presence usually excites catarrh; and as the foreign body is usually not aseptic, the catarrh may in a short time take on a gangrenous character, especially if the object is large and rough. Ulceration, gangrene, and perforation of the bladder-wall with infiltration of urine, may be the result. Perforation may also be produced by small pointed objects.

Fig. 181.



Calculus which formed in six weeks around a glass tube in the bladder.

The situation of a foreign body is determined largely by its specific gravity. Heavy objects lie in the lowest portion of the bladder, while light ones, such as wax, float on the top of the urine.

Threads stick to the wall, and pins usually become embedded in it. Stones, pencils, and other objects less than 10 cm. (4 inches) long usually lie transversely. Still longer objects take a vertical position in most cases.

FIG. 182.

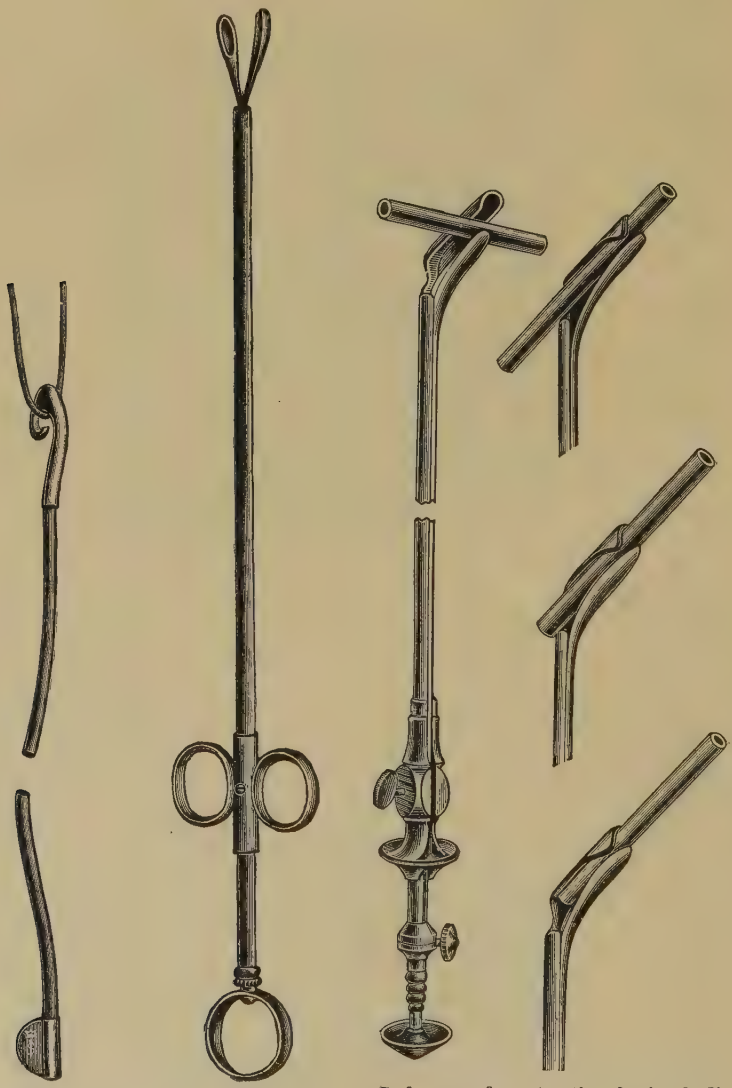
Hairpin forming the nucleus of a large calculus in the female bladder. (Wathen.)

Symptoms.—The symptoms produced vary greatly according to the character of the object and the state of the bladder. Rounded, smooth bodies need cause no symptoms if there is no cystitis, and in many cases pointed objects produce only slight symptoms. Thus, it is remarkable how little trouble may be caused by a hairpin in the female bladder. If a needle or pin is fixed in the wall of the bladder, there will be pain at the end of micturition, but the functional disturbances may be slight. If there is cystitis, the symptoms will be more severe, and they may reach the highest degree. When the object is thoroughly incrusted with salts, the symptoms produced are those of vesical calculus.

Diagnosis.—The diagnosis of a foreign body must usually be made from the symptoms and examination of the patient, since a history of the introduction of such objects for the purpose of sexual excitement can rarely be obtained. Furthermore, in some cases the patient will not have noticed the breaking off of a portion of a catheter. The symptoms, as above stated, are often indefinite, and hence the greater weight is to be laid upon an examination with the cystoscope, and other instruments. The sound is of value if the foreign body is hard and of sufficient size. The presence of a needle or hairpin cannot always be detected with certainty, and such soft objects as pieces of a rubber catheter cannot be felt at all. Such

objects are, of course, easily recognized by the cystoscope, which will show not only the presence of the object, but also its position, and whether or not it is free or fixed in the wall of the bladder.

Fig. 183. Fig. 184. Fig. 185.



Guyon's instrument for withdrawing fine bougies from the bladder.

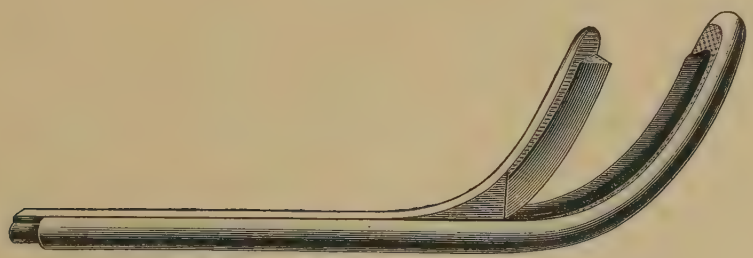
Hunter's straight tubulated forceps.

Redresseur for extracting foreign bodies from the bladder. (After R. Collin.)

Treatment.—Foreign bodies may be removed from the bladder either through the natural urethra, or the dilated female urethra, or through an incision in the male perineum, or through a suprapubic incision in either sex.

The object, if small, may be extracted through the urethra, or its pieces may be extracted after a larger object is broken up. There are special instruments for this purpose, the use of which is greatly facilitated by the cystoscope. The two instruments may be introduced together, or the cystoscope may be combined with an extractor. Such a manipulation requires considerable skill, and one familiar with the handling of these instruments may succeed in extracting a foreign body through the urethra which could only be extracted by a general surgeon through an incision. Such small foreign bodies, as beads, may be washed out through an evacuation catheter. Slender catheters and filiform bougies can be seized with a slender lithotrite and extracted. Larger bougies and catheters, and long, rigid foreign

FIG. 186.



Secateur for cutting foreign bodies in the bladder. (After Caudmont.)

bodies are more difficult to extract through the urethra. Ingenious instruments have been constructed to seize such an object, and follow along its shaft until the end is grasped so that it will lie in the long axis of the instrument, which can then be removed with the foreign body. Collin's redresseur is the best-known instrument of this type; but none of them is so useful as the operating cystoscope, with which one can seize the end of a foreign object under direct guidance of the eye. This is the only instrument with which it is safe to attempt extraction of a needle, or similar sharp metallic foreign body. The breaking up of such foreign bodies as glass tubes is dangerous on account of the wounds which their pieces may produce. A hairpin may be removed from the female bladder by means of a small hook and a cystoscope, so that the operator may guide the hook to the bent portion of the pin.

If a calculus has formed around the foreign body, this may be broken up and removed, like any other calculus, if the nature of the foreign body does not prevent. In case the foreign body itself is likely to give trouble in its extraction, or if there is a serious cystitis, suprapubic cystotomy in the male, and forcible dilatation of the urethra in the female, are usually the best methods of treatment. If the foreign body is small and round, perineal urethrotomy with dilatation of the prostatic urethra is a good operation to perform upon men.

CHAPTER XXIV.

DISEASES OF THE BLADDER.

VESICAL HERNIA AND PROLAPSE.

THE urinary bladder may be found in a hernial sac. The portion of the bladder which is thus found is usually the anterior or lateral wall, that is to say, some part which is not covered with peritoneum. Because, therefore, the affected portion of the bladder is not surrounded with a hernial sac some writers prefer to call this condition prolapse rather than hernia; but if a large part of the bladder is involved, the peritoneum must follow it to a certain extent and form a sort of sac. In rare instances the greater portion of the bladder is found free in the hernial sac and may be reduced through the hernial ring. The portion of the bladder in the sac may contain a calculus. In the majority of instances the vesical hernia does not occur alone, but is associated with hernia of the intestine. If, then, the hernial sac is opened and the intestines are replaced, the posterior wall of the sac will bulge forward and will fluctuate if palpated.

In women the commonest displacement of the bladder is into the vagina, giving a vaginal cystocele. As this condition has no hernial ring, it is properly called a vaginal prolapse of the urinary bladder (prolapsus vesicæ vaginalis).

Vesical hernia may be divided into three classes: intraperitoneal, extraperitoneal, and a third class which includes hernias which are partly intraperitoneal and partly extraperitoneal. Intraperitoneal hernias of the bladder are rare. Such a case is mentioned by Walter, who, after opening a hernial sac and exposing an incarcerated loop of intestine, found remaining there a prolongation reaching to the bottom of the sac, which was covered with peritoneum and distinctly fluctuated. It was attached above the symphysis pubis by a sort of pedicle, and was shown to be a prolongation of the bladder by the passage of a catheter.

In the usual intraperitoneal vesical hernia the conditions are as follows: The hernial sac is of large size and reaches into the scrotum. Its contents are generally the dilated and prolapsed urinary bladder. The ring is much distended, having a diameter of possibly 8 cm. (3.2 inches). The peritoneum of the bladder passes into that of the sac at the inner margin of the ring. The bladder is often twisted so that its summit with the urachus is less deeply

placed in the sac, while the anterior wall of the bladder is backward and the posterior wall forward. Even the prostate may be displaced into the sac. An intraperitoneal vesical hernia has also been found emerging from the crural opening. Extraperitoneal hernias are not common. Indeed, it is not known with certainty whether there was not in the recorded cases some peritoneal hernial sac in some portion of the hernia. The amount of bladder involved in this type of hernia is small, as large as a pigeon's or hen's egg.

The majority of hernias of the bladder are included in the third class. The portion of the bladder affected is partly free from peritoneum, partly covered by it, and the relation between the sac and bladder is therefore of the greatest importance. In inguinal vesical hernia the bladder is constantly found to the inner side and behind the sac. In crural hernia the bladder lies plainly on the inner side of the sac. In this type of hernia the sac usually contains intestine or omentum. Sometimes one of the tubes or ovaries is present. The relation between the size of the whole hernial sac and of the prolapsed bladder varies a great deal, although in general the sac is larger than the affected portion of the bladder, since the latter forms merely a thickening of the inner and posterior wall.

The inguinal vesical hernia may be external or internal. An external intestinal hernia may be associated with an internal vesical hernia, the two being separated by the epigastric artery or by a considerable portion of the inner wall of the inguinal canal. Sometimes the bladder seems to escape through a special opening in the abdominal wall, but even then it will be situated to the inner side of the epigastric artery. The connection between the affected portion of the bladder and the rest of the organ can only be made out by the passage of a metallic sound. Even in those cases in which the connection is a wide open one there is always a constriction at the neck. The wall of the affected portion of the bladder is either normal or hypertrophic. In rare instances it has been found very thin so as to rupture when drawn upon. Sometimes the muscular fibres have been noticed, while at other times there seemed to be only mucous membrane in the affected portion. The portion of the bladder involved may become strangulated, and this perhaps explains why in some of the cases it has been found in a suppurative or gangrenous condition ; but usually an inflammatory condition is due to extension from some other part, and not to strangulation. Calculi may be found in a diverticulum where they have probably developed in the stagnant urine. In certain instances the stone has ulcerated its way out, and has thus established the diagnosis. The tissues overlying the vesical prolongation are naturally the same as those found in an ordinary inguinal or crural hernia. The vas deferens has no relation to the bladder, and is usually not adherent to it. The portion of the bladder remaining in the pelvis is more or less reduced in size according to the size of the hernia. It may

be reduced to a mere canal which leads from the urethra to the hernia.

In other cases the hernia begins extraperitoneally. Such a hernia, it has been claimed, can be produced by the radical operation upon an inguinal hernia. The hernial sac is ligated as high up as possible in order to prevent the development of a peritoneal funnel which may lead to recurrence. The pulling upon the peritoneum which this involves unquestionably drags the peritoneum from the bladder into the hernial canal, and this may be the starting-point for an extraperitoneal vesical hernia. This opinion is shared by no less an authority than Kocher. If after such a radical operation recurrence of the hernia takes place, the bladder is already close to the hernial ring; and if a second operation is performed on account of the recurrence, the bladder may easily be injured, especially if a new attempt is made to separate the hernial sac as high up as possible. It is desirable, therefore, in operating upon this type of vesical hernia to note whether the bladder lies naturally in the hernial sac when no tension is made upon the peritoneum, or whether it is drawn into the hernial cavity by the tension. If the latter is the case, it may be spoken of as an operative cystocele. If when no tension is made it lies partly within the hernial canal, it is a true preformed vesical hernia.

Opinions differ as to the relation of adhesions between the bladder and the peritoneum to the development of vesical hernia; but in general this relation is unimportant. Holländer mentions an instance in which the bladder became adherent to the peritoneum and was drawn with it into a hernial sac. Jüterbock mentions a case in which the omentum became adherent to the bladder and with it entered a hernial sac. Sonnenburg mentions an adhesion between the omentum and the bladder which led to resection of a portion of the bladder-wall which passed unnoticed by the operator. In another instance the bladder was wounded to the outer side of the crural ring, an occurrence which can only be explained by previous peritoneal adhesions.

Most vesical hernias are found in the inguinal canal or in the crural canal; though in a few cases the hernia has been found in the perineum or in the obturator foramen or sciatic foramen, or in a slit at the outer border of the rectus muscle somewhat above and to the median side of the external inguinal ring. These unusual forms of vesical hernia are mentioned by early writers, but there is some question as to the correctness of these observations.

A vesical hernia occurs more frequently in advanced age. It has been mentioned especially in the decade between fifty and sixty years, although it may occur as early as the thirty-eighth year of life. It is rare in childhood. It is mentioned much more frequently in the recent statistics of hernia than formerly, a fact which is due to the great increase in the number of radical operations for hernia.

Diagnosis of vesical hernia from the symptoms present has rarely been made before operation. It has sometimes been made during operation and injury of the bladder thereby avoided. Still more frequently, however, the bladder has been wounded during operation, and the diagnosis has been thus made for the first time. In about two-thirds of the reported cases (Hermes) in which this accident happened the nature of the injury was recognized and proper measures to relieve it were taken. In the remaining third the accident was not discovered until some hours, and perhaps some days after the operation.

Etiology.—The following conditions favor the development of vesical hernia:

1. The bladder must be frequently and for long periods over-distended.
2. The wall must be weak and its contractility somewhat lessened.
3. The hernial opening must be elastic.

These conditions are found in cases of stricture, of pelvic tumors, and especially of hypertrophy of the prostate.

In the cases in which the bladder has been injured at operation (Hermes) it has been mistaken for the hernial sac six times, for a much thickened hernial sac once, for a subserous lipoma four times, for an inguinal hernia once, for an omentum once, for a cyst once. Injury of the bladder during operation has been due to ligation sixteen times, the bladder being included in the ligation of the neck of the sac or being ligated separately. It has been injured by incision seventeen times, torn into by dissection with the finger five times, and has also been injured by blunt dissection with the scissors.

Symptoms.—A vesical hernia is usually marked by disturbances in micturition. The patient is not able to pass urine when in all positions, but must take a certain position, and must usually press with his hand against the hernia. Sometimes the urine can only be passed drop by drop. Sometimes it is passed in two sections, that which is contained in the bladder coming first and afterward that contained in the vesical hernia. The hernia is increased in size when the bladder is fully distended. At such a time a round fluctuating tumor is palpable in the internal ring. Such a tumor is usually irreducible, and remains so even though the rest of the hernial contents are completely reduced. It is often possible to demonstrate the relation of the tumor to the bladder either by means of the catheter or by injecting fluid into the bladder and watching the vesical hernia distend. Sometimes the symptoms are so marked that the patient himself is able to make the diagnosis. In most cases, however, such well-marked symptoms are absent, and therefore discovery has come as a surprise to the surgeon during operation upon an intestinal hernia.

If before operation no symptoms have aroused a suspicion of vesical hernia, it is all the more important that the operator should

be familiar with the conditions which when found during the operation suggest vesical hernia. He will then be able to make a correct diagnosis and avoid wounding the bladder. All writers who have thus avoided injuring the bladder state that their attention was first directed to the possibility of a vesical hernia by the presence of a mass of fat—a lipocele, as it has been called. This mass of fat is either diffuse or it is in the usual form of a lipoma. Its color is lemon yellow or grayish yellow. It is usually situated at the inner side of the hernial canal, and the peritoneum overlying it is so firmly attached to it that it cannot be pulled off readily, but must be separated by instruments. The suspicion of vesical hernia, if thus aroused, will be confirmed on further dissection by the discovery of the peculiar net-like muscular structure of the bladder. Furthermore, the passage of a catheter into the bladder will demonstrate its close relation to the hernia; or the finger may be passed along the suspected vesical hernia, and will find that it extends behind the symphysis into the pelvis. It is not known what relation this mass of fat bears to the development of vesical hernia. It is known that a vesical hernia is almost always an acquired condition. This is shown by the frequency of its occurrence at an advanced age. Congenital diverticula can, of course, give rise to vesical hernia. It is especially interesting to observe that the operators who have wounded the bladder during operation have also mentioned the occurrence of this fatty mass in the hernial canal. Justo made a diagnosis of vesical hernia from the patient's symptoms before operation, and in spite of this fact he cut into the fatty mass and opened the bladder because he was unable to distend this portion of the bladder by fluid, and thus concluded that no vesical hernia existed.

Treatment.—If the diagnosis of vesical hernia can be made, radical operation is feasible, since any truss, no matter how ingeniously constructed, will cause the patient so much pain that he will soon give up trying to wear it.

If the vesical hernia is recognized either before or during operation, it is to be separated as far as possible and replaced, and the operation for hernia carried out as usual. This separation of vesical hernia can best be performed by blunt dissection. The mass of fat which is almost always present should be removed in order that the bladder may be clearly recognized and replaced. Certainly this method of procedure is less dangerous than resection of the bladder recommended by Monod, in order to facilitate reduction of the hernia and to prevent its recurrence. On account of the uncertainty of a suture of the bladder the risk of resection is by no means small. If the affected portion of the bladder appears gangrenous, it must, of course, be resected if it is possible to make incision through healthy tissue. If the gangrene is too extensive to permit this, the wound should be packed with gauze, and the patient must content himself with a urinary fistula.

If the bladder is wounded during the operation, its treatment takes precedence of the radical cure of the hernia. Referring again to Hermes' statistics, it appears that the bladder was sutured immediately nineteen times, two hours later once, and twenty-four to forty-eight hours later four times; that the wound in the bladder was sutured with the wound in the skin twice, and that the wound was tamponed with gauze without suture once. In 5 cases urinary fistula developed which healed spontaneously, and once a fistula developed in six weeks as a result of the working outward of silk stitches. Death followed injury of the bladder in 11 cases.

Immediate suture of the bladder is undoubtedly the best form of treatment provided that the stitches can be inserted in healthy tissue. The easiest method of suture is to invert the edges of the wound and sew the bladder-walls in layers. When this has been done, the surgeon must decide whether he will separate the bladder and reduce it or will tampon the wound. Although some operators have succeeded in reducing the sutured bladder and closing the hernial canal throughout without drainage, it is doubtless better practice in most cases to tampon the wound until it is shown that the suture in the bladder will be perfect. It is impossible to know whether the bladder-wall which has been sutured is thoroughly healthy, and, moreover, stitches in the bladder may give rise to fistula even after the lapse of considerable time. If the injury of the bladder is not recognized until after the operation is completed, the treatment will depend upon the length of time which has elapsed. If not more than twenty-eight or forty-eight hours have gone by, it is not too late to make a successful suture, as recorded cases have proved. If a urinary fistula develops, the chances are favorable that this will ultimately close spontaneously.

VAGINAL CYSTOCELE.

Etiology and Pathological Anatomy.—The causes of vaginal cystocele are pregnancy, or many or difficult labors. As a result the structures which make up the pelvic floor are strongly pressed downward and stretched, while at the same time the entrance to the vagina is distended and the wall between the vagina and bladder is loosened and its natural supports fall forward, carrying the bladder with it. This condition is favored by the existence of perineal laceration. Heavy lifting, or carrying heavy weights, or increased abdominal pressure from other causes, favors the development of a cystocele. The dilatation of the bladder-wall is usually primary, but it is apt to be followed by an incomplete prolapse of the uterus. The age of the patient affected is usually thirty or forty years. In lesser degrees of vaginal cystocele the lower portion of the bladder is simply deeper than normal. In cystocele of the middle grade the bladder is divided like an hour-glass into two almost equal portions.

In the highest grade of cystocele, especially if accompanied with complete prolapse of the uterus, the whole bladder is so displaced that the urethral orifice lies at its highest portion and the urethra leads vertically downward into the inverted bladder, whose fundus is below, not far from the os uteri. A calculus may form in the cystocele due to stagnation of the urine.

Symptoms.—If the cystocele is of slight degree, it causes few or no symptoms. The symptoms of cystocele of a more marked degree are pain, frequent urination, and a tendency to catarrh of the bladder. Some patients have the habit of pushing the bladder upward with the fingers in order to empty it completely during urination.

Diagnosis.—The patient herself notices the appearance of the tumor in the external genitals. The diagnosis is easily made, especially if the patient lies upon the back with the thighs flexed, when with increased abdominal pressure the anterior vaginal wall together with the bladder will immediately present itself between the labia. Malgaigne found that cystocele was present 39 times in 74 cases of prolapsus vaginæ. With a male catheter it is easy to demonstrate the existence of a cystocele if the instrument is passed with its concavity downward.

Prognosis.—The pains caused by a cystocele are considerable, and although the prognosis as to life is favorable a cure is to be expected only after operation. The mechanical means which have been devised to overcome the displacement are for the most part unsatisfactory. Radical operation consists in removal of an oval area of the anterior vaginal wall and suture of the wound (anterior colporrhaphy); the length and breadth of the portion excised should correspond to the degree of eversion and the size of the cystocele. If the cystocele is large, the incision should reach from the orifice of the urethra to the anterior lip of the cervix, and should include a portion of tissue 8 cm. (3.2 inches) broad. In cystocele of extreme degree anterior colporrhaphy is not sufficient, but must be combined with posterior colporrhaphy. For the details of these operations the reader is referred to text-books on gynecology.

The bladder may be pushed through the dilated urethra. The mucous membrane alone may project from the urethra, or, in rare instances, the whole thickness of the bladder-wall. Such a prolapse may reach the size of a pigeon's egg, or even a hen's egg, and may occur in childhood or in adult life. A polyp of the bladder is usually the exciting cause of such prolapse. The operation for its cure consists in removal of the polyp and narrowing of the urethra.

CYSTITIS.

Etiology.—The importance of the term idiopathic catarrh of the bladder has been much lessened by the bacteriological examinations of the last few years. Some discoverers even go so far as to say

that there is no such thing as an idiopathic cystitis. Englisch believes that such a condition may develop idiopathically, as, for example, if the whole mucous membrane from the kidney to the neck of the bladder suddenly becomes inflamed in a patient who is suffering from influenza or some other infectious disease. The symptoms which usually accompany a so-called idiopathic cystitis are high fever, with or without chill, and vesical tenesmus, which may be so intense that no urine can be passed. The bladder of such a patient will be found extremely tender, but only moderately distended. By means of the catheter a small quantity of high-colored urine of high specific gravity may be drawn. As the bladder is emptied, its walls close around the end of the catheter and fresh blood flows through the instrument. The sediment of the urine contains mucus, red blood-corpuscles in abundance, and a few leukocytes. Two or three days later renal epithelium and casts will also appear. If such a bladder is examined, its mucous membrane will be found universally swollen and its capillaries injected. The redness and swelling will exist to a greater or less extent in the pelves of the kidneys and in the ureters. The renal parenchyma has the appearance of an acute nephritis.

Unquestionably most of the inflammations of the bladder are due to bacteria. Still, bacteria may be present in large numbers in the urine without exciting cystitis. There must be some disposition to the disease as well as the presence of the bacteria. Predisposing factors are congestions of the bladder, such as may be produced by exposure to cold, by traumatism, by strong diuretics, by balsams and cantharides. Other predisposing causes are: inflammations of the urethra, retention of urine, especially if due to hypertrophy of the prostate, the presence of a calculus, or, in women, inflammatory processes in the neighborhood, which may easily extend to the bladder. Therefore among women cystitis is a frequent affection, although it is not usually so severe in degree as when it occurs in men. Cystitis in women may also be due to pressure upon the bladder by a misplaced uterus, or retention of urine, favored by some new growth. The more marked the predisposition to cystitis, the more intense it is likely to be. If, on the other hand, the predisposition is slight or temporary, as, for example, temporary retention of urine requiring catheterization, the cystitis is likely to disappear as soon as the cause is removed. Even if the cause of the cystitis has existed for a long time, removal of the former may be followed by rapid disappearance of the latter; for example, in the case of vesical calculus.

There is no such thing as a purely traumatic cystitis; still, cystitis is often seen after operations upon the bladder, and even when the bladder is simply drained. This is due, not to the traumatism, but to the infection which follows it. The traumatism lessens the power of resistance of the bladder and thus

affords a favorable field for the localization of micro-organisms either in the bladder or in the tissues about it. In a similar manner injuries of the spinal cord by weakening the muscular structure of the bladder predispose it to infection. The agents of infection may be introduced directly into the bladder, or they may enter it through the ureters, or as a result of injury of the bladder. If the renal capillaries or the epithelium lining the glomeruli are diseased, bacteria may pass from the kidney into the bladder. The same may happen if there is diffuse primary or secondary inflammation of the kidney. It is probable that the bladder becomes infected in this manner in the case of infectious diseases.

As micro-organisms do not act upon a healthy mucous membrane to produce inflammation, it seems probable that the power of absorption of the healthy mucous membrane of the bladder is very limited. It is not intended to secrete fluid, and contains few lymph-vessels.

In order to show that a given bacterium is the cause of a cystitis it is necessary to obtain it in pure culture from the urine. Furthermore, this pure culture must be capable of exciting cystitis. There are a large number of bacteria which are able to do this, among which may be mentioned bacillus pyocyaneus, several sorts of pyogenic staphylococci, bacterium coli, the typhoid bacillus, bacterium ureæ, and bacillus proteus. Heyse describes a case of cystitis due to a gas-forming bacterium. The part which the gonococcus plays in the development of cystitis is not yet determined. The tubercle bacillus will be spoken of later. The majority of infections of the bladder occur through the urethra. If the urethra is diseased and contains pathogenic bacteria, catheterization even with aseptic instruments may easily lead to infection of the bladder. In this manner infection occurring in patients suffering from stricture of the urethra is to be explained. This explains also why infection from this cause is less frequent in women than in men.

Infection due to bacterium coli is relatively common. These bacteria are excreted through the kidneys and find their way through the ureters to the bladder. Cases of cystitis in children may occur in this manner ; but as most of them are found in girls, it is more likely that the enteritis is followed by proctitis and a vulvovaginitis, and that the intestinal bacteria make their way through the urethra into the bladder. If diarrhœa is present, the urine is diminished in quantity, it is more concentrated, and lies a longer time in the bladder. The congestion thus caused is favorable to the growth of bacteria.

The bladder may be invaded by microbes penetrating its wall or entering it through abnormal communications either congenital or acquired ; as, for example, through a rectovesical fistula. The infection may also be due to ulceration and tumors in its neighborhood. Microbes alone cannot give rise to cystitis. There must be a predisposing hereditary or acquired cause, chief among which

are the alterations in the bladder itself which have been described above.

When bacteria enter the bladder, they may disappear from the urine without setting up a cystitis. This may, however, take place at any moment. The micro-organisms which have entered the bladder multiply in the urine and react upon the mucous membrane, which shows signs of inflammation. Whether these inflammatory processes are started by the ammoniacal urine or whether the germs enter the mucous membrane through epithelial defects, is not at present clear.

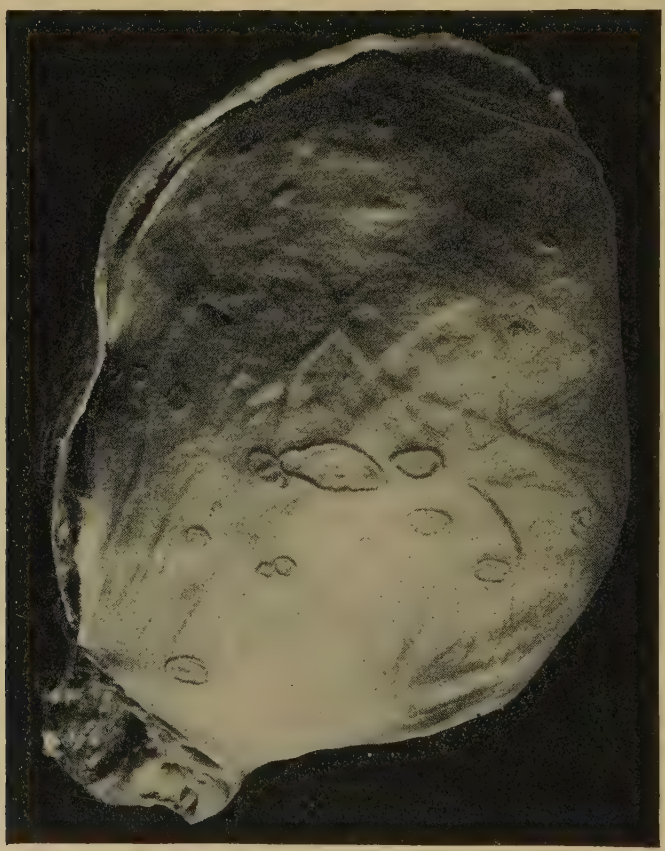
Attempts have been made by experiments upon animals to determine in how far imperfect emptying of the bladder is able to produce cystitis. Cohnheim found that the urine remains perfectly clear in a dog's bladder after the ureter is ligated. In hydronephrosis occurring in man the urine may remain clear and acid for months. Therefore Cohnheim concludes that degeneration of urine does not take place until bacteria enter it either through the urinary passages or from neighboring organs. Undoubtedly the catheter is the commonest source of such contamination. By the action of bacteria the urates which are in solution are changed into ammonium carbonate. Thus, according to his investigations, the two factors of stagnation and bacteria are necessary. Neither one alone is sufficient to excite cystitis. Schüller came to a different conclusion. He passed a ligature around the urethra so as to form an artificial stricture, but did not draw it tight enough to obstruct the flow of urine. He found that the urine in the bladder became alkaline in two days, but speedily became acid if the ligature was loosened. His experiments were unreliable since there was nothing to prevent the passage of bacteria through the urethra to the bladder even though at the site of stricture there were no evidences of inflammation. Other discoverers have mentioned results substantially in accord with Cohnheim's conclusions.

In the case of males who have passed the age of puberty and are in a condition of health cystitis is usually due to infection by the gonococcus. This occurs most frequently in the latent form of gonorrhœa. In old people of both sexes, but especially of the male sex, inflammation of the bladder is of frequent occurrence.

Tuberculous cystitis is not confined to any age or either sex. Like tuberculosis in other organs, it may develop independently or secondarily to the disease elsewhere in the body. (Fig. 187.) It is not very often seen as a complication of pulmonary tuberculosis, but occurs more frequently after tuberculous disease of the bones or joints. Tubercle bacilli find their way into the bladder when the patient is suffering from tuberculosis of any organ just the same as the bacteria of other diseases find their way into the urinary current. Even though they enter the bladder, they do not necessarily set up a tuberculous cystitis. If tuberculosis does develop in the bladder, it usually

begins at the base of the bladder near the internal urethral orifice. This shows that tubercle bacilli, like other micro-organisms, settle to the lowest layer of urine, and develop there. For a similar reason peritoneal tuberculosis shows the most marked lesions in the pelvis. Tuberculosis of the bladder occurs most often between the twentieth and fortieth years of life.

Fig. 187.



Tuberculosis of the bladder. (Taylor.)

Pathological Anatomy.—The first appearance of cystitis is in the fundus and neck of the bladder, where there is a general injection of the capillaries of the mucous membrane. Later there are desquamation of epithelium and suppuration. If the whole bladder is inflamed, the hyperæmia is general. In either form there are numerous calices, sometimes disposed individually and sometimes in rows. As is well known, the normal bladder is abundantly supplied with vessels, and especially with capillaries. This rich capillary supply

is particularly well marked in the trigonum, hence the changes which cystitis causes are especially evident in this portion of the bladder. If the cystitis goes on to desquamation of epithelium and suppuration, there is a mucopurulent sediment in the urine which, examined microscopically, will be seen to be made up of epithelial cells, leukocytes, and earthy phosphates. The reaction of the urine is alkaline, and the amount of albumin which it contains corresponds to the quantity of pus present..

By counting the pus-corpuscles present in the urine it is often possible to tell whether the albumin is due to them or whether it has another origin. Even a great number of pus-corpuscles produce only a small amount of albumin ; 100,000 in a cubic millimetre are not responsible for much more than 1 per cent. of albumin. Naturally such an examination does not determine the origin of the albumin if it is present in a greater quantity than can be accounted for by the number of pus-corpuscles. This counting of the pus-corpuscles is a tedious task, and Posner has attempted to simplify the test by comparing the transparency of the urine with a fixed scale, and in this manner estimating the amount of pus present. No especial apparatus is necessary. An ordinary beaker glass is placed upon a printed paper, and the urine is poured into it until it is no longer possible to see the letters which are printed on the paper. The depth of urine in the glass measured in centimetres indicates the degree of transparency of the urine. When this test has been controlled a few times by counts of the pus-cells, it becomes a fairly accurate one to estimate the amount of albumin which can be attributed to the pus-corpuscles present.

As the disease progresses the mucous membrane of the bladder becomes slaty gray or brownish red, and the veins are dilated, the surface of the bladder is covered with yellowish pus, the mucous membrane is thickened, and the submucous cellular tissue is infiltrated with cells. The mucous membrane is easily stripped off from the underlying tissue. A few abscesses may develop as a result of chronic cystitis. They are usually minute, perhaps only microscopical. If larger abscesses form, they may break outward and so give rise to pericystitis. Such a process may heal and leave the bladder adherent to neighboring organs. There may also develop gangrenous necrosis of the mucous membrane if the disease is extremely severe in type, but such instances are rare Sometimes the various stages of the disease are all found at one time. Under these circumstances the urine is much degenerated and intensely irritating to the tissues. Incrustation with urinary salts is not uncommon. This gives rise to more or less ulceration. The muscular bundles resist ulceration for a long time, so that they may be undermined and stand out like bridge-work, or, being loosened at one end, they may float in the contents of the bladder. In gangrene the bladder is lax and dilated, its muscular structure being paralyzed. Its contents are made up

of urine, blood, pus, urinary sediments, and portions of gangrenous tissue. The mucous membrane is softened, discolored, and in places gangrenous, while the peritoneal surface is injected and more or less discolored.

A special form of cystitis to which the term membranous or diphtheritic is applied, occurs chiefly in women. There is throughout the bladder the formation of a thin fibrinous exudate such as may be observed after poisoning with cantharides. Sometimes this fibrinous layer may be peeled off from the bladder as a complete membrane, leaving beneath it a much inflamed mucous membrane. The diphtheritic form of disease shows the most intense changes. There are numerous and extensive ulcers with discolored sloughs and submucous and perivascular inflammation and suppuration. Dirty yellowish spots and strips are scattered over the mucous membrane. The exudate may be hemorrhagic.

There may be partial or total separation of the mucous membrane of the bladder, as in the case described by Schatz. This patient suffered from strangulation of a retroflexed pregnant uterus and died seven hours after expulsion of the fœtus, which measured 17.5 cm. (8 inches) in length and weighed 154 grammes (5 ounces). The whole mucous membrane of the bladder had separated itself, together with a considerable part of the muscular tissue, from the outer connective-tissue layer of the organ.

Cases of isolated ulceration of the bladder are also described. At first the urine is acid and otherwise normal. Such an isolated ulcer develops from bacteria derived from the blood-stream. When the abscess cavity has extended to the surface, it ruptures, and the result is an ulcer. Such isolated ulcers of the bladder are said to occur in younger individuals just as ulcers of the stomach and duodenum. There is no predisposing local cause for them as far as known.

If in addition to the cystitis there is stricture of the urethra or hypertrophy of the prostate, or some other obstruction to the flow of urine, the muscular layer of the bladder becomes much thickened. The muscular bundles nearest the mucous membrane are pressed into the lumen of the bladder like strong bands. If at the same time the bladder is dilated, an excentric hypertrophy will exist. (Fig. 188.) If the bladder is contracted, there will be a concentric hypertrophy. (Fig. 189.) In either case the spaces between the trabeculæ may dilate and extend toward the serous coat. Such little pockets are called diverticula. They have a great clinical importance since they are the cause of the most obstinate form of cystitis.

Tuberculosis of the bladder is either localized in the trigonum and neck of the bladder or it is a diffuse affection of the mucous membrane. The process may be either superficial or ulcerative. The ulcers are often situated around the orifice of the urethra, but they may occur elsewhere. They are usually found in groups. Examination will

also reveal the presence of larger and smaller tubercles in the neighborhood of the ulcer and which may extend along the ureter to the kidney. Sometimes a tuberculous ulcer perforates the wall of the bladder and establishes an opening into the peritoneal cavity or into the rectum. On the whole, tuberculosis of the bladder as a separate disease is rare, while the bladder is often affected secondarily to tuberculosis of the kidney, testicle, or prostate.

A single case of thrush of the bladder was reported by Frisch in 1898.

Symptoms.—Cystitis may be either acute or chronic, but the acute form is prone to pass into the chronic, and there are apt to be acute exacerbations in the chronic cases. Fever is not a common accompaniment of acute cystitis, but is observed in the case of individuals who are much run down or who react violently to disease. If the fever is high, the case is usually a severe interstitial cystitis or paracystitis. The most important symptom of cystitis is tenesmus. The sphincter may be so strongly contracted that the bladder cannot be emptied or only partially emptied. These two conditions produce the pain and tenesmus. This tenesmus may be continuous, while the patient repeatedly evacuates a few drops of urine with great pain, referred either to the rectum or perineum, and extending to the tip of the penis. The pain is greatest just before and during the act of micturition.

In the beginning of the cystitis there may be little or no pus in the urine. In order to recognize its presence the urine should be passed into two or three glasses. If the first portion of urine contains much pus, the seat of the disease is probably in the posterior urethra and the trigonum; whereas if the last portion contains pus, it is fair to assume that inflammation has extended higher up in the bladder.

The urine in cystitis often contains red blood-cells, epithelial cells from the bladder, and numerous bacilli and cocci. If at the same time one kidney is diseased, epithelium from its pelvis and casts of its tubules will also be present.

If the urine has undergone fermentation in the bladder, chiefly on account of bacterium ureæ, the quantity of albumin will be larger than the amount of pus present can account for. However, it is not safe to conclude on this account that the surplus comes from the kidney. The development of ammonium carbonate in the urine gives to it a peculiar odor which is recognizable even if the urine be not alkaline. It is, of course, more likely to be acid if tested as soon as passed. Acidity of the urine is therefore no counterindication to the diagnosis of cystitis.

If the bladder is not too tender and the cystitis has not changed from the acute to the chronic form, it may be possible to make a cystoscopic examination. If so, the inflammation will be manifest in the form of isolated spots and patterns, dark red or bluish brown

or gray. These patches are found in the lower portions of the bladder and about the urethral orifice. They are united to each other by dark-red stripes.

Diagnosis.—If one pays attention to the three cardinal symptoms of tenesmus, pain, and pus in the urine, it is not difficult to make a diagnosis of cystitis. All three symptoms should be present.

In making the three-glass test, about 50 c.c. of urine should be passed into the first glass so that one may be sure that the pathological products of the urethra are contained in the first glass. The other two glasses will both contain a mixture of elements from the kidney and bladder. If all three portions of the urine are cloudy, further tests are necessary in order to separate cloudiness due to urethral disease from that due to vesical or renal disease. Cloudiness may be due to urinary salts or to cellular contents (pus and blood) or to bacteria. If, when the urine is warmed in a test-tube it becomes perfectly clear, the cloudiness is wholly due to urinary salts. If the cloudiness increases when the urine is warmed, a few drops of acetic acid should be added; if it then becomes clear, the cloudiness was due to an excess of phosphates. Such urine is alkaline. Simple phosphaturia is produced by general causes, and is found in the case of nervous individuals after the ingestion of certain articles of food and drink. If potassium hydrate is added to urine and the mixture then heated, and the steam changes red litmus-paper to a blue, there is ammonium phosphate in the urine. This indicates a decomposition of the urea, which is usually the result of a serious infectious catarrh. If the urine remains cloudy after heating and after the addition of acetic acid, but becomes clear when hydrochloric acid is added, the cloudiness is due to the presence of calcium oxalate. Oxaluria irritates the bladder and urethra, and often produces severe symptoms, giving rise to white and even red blood-corpuscles in the urine, which may serve to obscure the diagnosis. If the urine remains cloudy after all of the tests mentioned above, it should be mixed with potassium hydrate and shaken. If it then assumes a gelatinous transparency, its cloudiness was due to pus-corpuscles. This test is known as Donne's test for pus. The reaction of urine in a case of intense cystitis with ammoniacal decomposition is a similar one. The free ammonia transforms the pus into tenacious, stringy masses which are sometimes present in such quantity that they interfere with the flow of urine from a glass. These masses are quite different from true mucus, although the name mucus has often been mistakenly applied to them.

The urine should next be tested for blood according to Heller's method. A test-tube is filled one-half full of urine. A little potassium or sodium hydrate is added and the mixture is boiled. The earthy phosphates are precipitated as basic salts and carry with them any blood-pigment which may be present. When the urine is

cool, the sediment should show a reddish tint. The result will be the same whether the blood-pigment is in solution or is contained in the blood-corpuscles. If the cloudiness remains in spite of all the tests thus far mentioned, it is fair to assume that bacteria are present. This must be determined by the microscope. It should be remembered that cloudiness may also be due to fat or chyle. If such is the case, the addition of ether will serve to clear the urine.

Every pyuria and every hæmaturia is associated with a certain amount of albuminuria. It is necessary to estimate the quantity of albumin in order to see whether it corresponds to the amount of pus or blood present, and for this purpose an Esbach albuminometer is to be recommended. Even a marked pyuria will account for only about 1 part in 1000 of albumin. If the quantity exceeds this, one should think of complications referable to the kidneys, heart, etc. If there is no precipitate of albumin on boiling, a test should be made with a 10 per cent. solution of ferrocyanide of potassium, which is one of the best methods of testing for albumin.

In order to make a microscopical examination the urinary sediment should be separated by means of a centrifuge. The microscopical appearance of the sediment varies according to the relative quantity of the substances which form it. Thus it may be cloudy or tenacious or sandy, and have a white, red, or yellow color, etc. If there is pure blood in the urine, the centrifuge will give characteristic drops like sealing-wax. Bacteria in the urine are not precipitated as sediment by the centrifuge. If a small quantity of the sediment is placed upon a glass slide under a microscope, three constituents may be seen : amorphous masses, crystals, and cellular structures. Urates and phosphates are amorphous. A drop of hydrochloric acid will dissolve them. Urates will then appear as fine rhombic plates of crystalline uric acid. Sodium urate and calcium phosphate appear in the form of needles which have a tendency to group in rosettes. Ammonium urate appears in little spheres covered with prickles. Other constituents not so often seen are tyrosin, fat-crystals, and crystals of hæmatoidin. Cystin is sometimes found in the form of thin, regular six-sided scales. Cholesterin forms thin rhombic plates with corners which are sometimes especially well marked. If there is fat in the urine, cholesterin is likely to be found. Crystals which form in three dimensions are uric acid or calcium oxalate, or ammoniomagnesium phosphate. Calcium oxalate crystals have eight sides, and through the microscope look like the back of an envelope. Many ammoniomagnesium phosphate crystals are prismatic or of irregular form. Sand in the urinary sediment is not a collection of irregular crystals, oxalates, and phosphates, as was formerly supposed, but consists of fine particles of organic material in which urinary salts have been deposited. This formation is therefore like that of a urinary calculus.

Experience has shown that it is unsafe to make a diagnosis of the seat of disease from the appearance of the epithelial cells found in the urinary sediment. Cells from the kidney are easily recognized. Aside from this the shape of the cell gives little clue to its origin, since similar cells may be found in the different portions of the urinary tract. Moreover, inflammation often changes very much the character of the epithelial cells. Posner's conclusions with reference to cellular sediments are as follows: Normal urine may contain a few delicate squamous epithelial cells that come from the bladder and are washed off by the flow of urine. In women squamous epithelial cells from the vulva or vagina may also find their way into the urine. Cells are sometimes found grouped together so that they appear like a fragment of tissue; for example, in the form of tubules, or like a little tassel with a bloodvessel in the centre. The latter appearance is the proof of the existence of papilloma. If a tumor is present, the urine frequently contains bits of tumor-tissue or of connective tissue showing cellular infiltration. It is impossible to determine the character of the growth from such fragments. Renal elements can be recognized, especially the well-formed cubical epithelial cells and casts of the urinary tubules, whether hyaline, granular, fatty, waxy, or epithelial in character. Such casts show that the kidney has been affected by disease. Under such circumstances an abundance of leukocytes goes to show that the inflammation is active, while an abundance of epithelial cells indicates repair and a new growth of the epithelial layer.

While epithelial cells may be found in normal urine, the appearance of round cells in the sediment indicates disease of the bladder or pelvis of the kidney, or of the kidney itself. Pus-cells are not always easily recognized, especially if the urine contains free ammonia, which changes their form. A dry preparation of sediment may be stained and examined for pus. It is impossible to recognize the origin of pus which the urine may contain. The old idea that urine is acid in pyelitis and is alkaline in cystitis, is not always true, since it is frequently acid in cystitis. Sometimes the history of the trouble or the other symptoms will enable one to form a conclusion as to the source of the pus; for example, if the inflammation is known to have extended into the bladder from the urethra, or if after an attack of renal colic sand and pus are found in the urine. By means of the cystoscope one can determine whether the bladder is inflamed or not, and whether purulent urine is flowing from one or the other ureter. Catheterization of the ureters is also helpful in making an exact diagnosis. That which has been said above in regard to the source of pus is equally true of blood in the urine.

Urine which contains bacteria is cloudy and usually has an acid or neutral reaction, and a peculiarly disagreeable odor. If the urine in the test-tube is whirled about, a fluorescent wave-like

appearance results which is characteristic of bacteriuria. Such urine should be examined microscopically as soon as possible, otherwise bacteria will enter it from the air, and rapidly multiplying will give a false impression as to the condition of the urine. In bacteriuria tenesmus of the bladder is seldom noted. This point may be of service in making a differential diagnosis between this condition and that of vesical catarrh.

Fig. 188.

Excentric hypertrophy of bladder. (Guyon.)

If ammoniacal fermentation of the urine and suppurative cystitis and retention of urine are all present at the same time, there results not infrequently a urine of the consistence of honey, which flows very slowly through a catheter. This condition is due to a change of the pus into an albuminous substance through the action of the ammonium carbonate. In gangrenous cystitis the urine is yellowish brown or dark brown in color and has a dirty appearance and foul odor. The odor may be so strong and disagreeable that the room is filled with it as soon as the urine is passed. The reaction is usually alkaline and the specific gravity low. Such urine contains albumin, coloring-matter of the blood, ammonium carbonate, and ammonium sulphide. Microscopically examined, it will be seen to contain detritus,

cocci, and bacteria, but few cellular elements, since most of the cells have degenerated.

Hypertrophy of the bladder due to cystitis may be recognized by bimanual palpation, with one finger in the rectum and the other hand above the symphysis. The bladder will then feel like a soft tumor. Furthermore, if an instrument is passed into the bladder, the increased thickness of the wall of the bladder may be recognized by palpating the tip of the sound through the abdominal wall. The projection of the muscular bundles into the lumen of the bladder may also be recognized through the cystoscope. In the so-called excentric hypertrophy of the bladder (Fig. 188) the capacity may

FIG. 189.

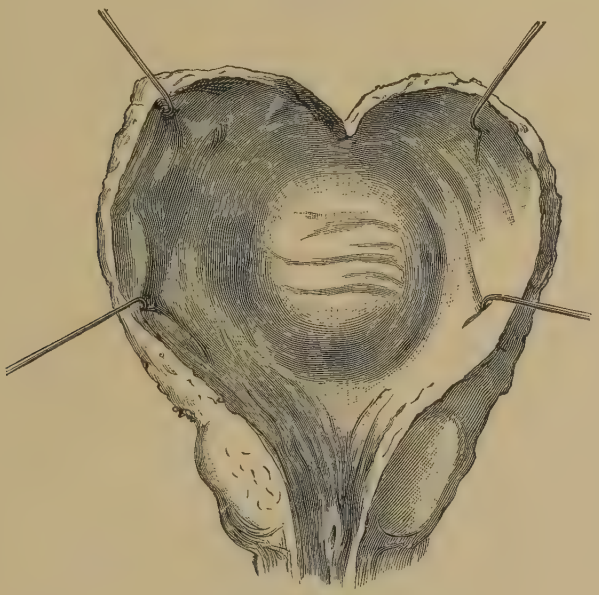
Concentric hypertrophy of bladder. (Guyon.)

be much increased, and as the bladder is unable to empty itself completely a considerable quantity of urine may be drawn with the catheter immediately after the patient has micturated. In concentric hypertrophy of the bladder (Fig. 189) its capacity is very limited, so that little or no urine can be obtained through the catheter after micturition. Such a bladder is not distensible to any degree, and very little fluid can be injected into it.

Interstitial cystitis which has lasted some time produces a small, firm, contracted bladder. (Fig. 190.) The muscular coat of the bladder has lost its elasticity as a result of the inflammation, and although the walls of the bladder are not especially thickened, the

capacity of the organ is very limited. Examination with a sound shows that the inner surface of the organ is smooth. This bladder is usually capable of emptying itself. Such a contracted bladder is often found in younger persons as a result of gonorrhœa. Concentric hypertrophy of the bladder is usually found in old men associated with hypertrophy of the prostate.

FIG. 190.



Contracted bladder. (Guyon.)

Cystitis which is secondary to pericystitis is usually characterized by the presence of pus, necrotic tissue, etc., in the urine. The pericystitis itself may be due to traumatism or to inflammation in the intestine in the neighborhood of the bladder, or to injury following the use of instruments. Pericystitis frequently develops in connection with a diverticulum of the bladder. The exudate which accompanies the pericystitis may gradually be absorbed, or it may result in suppuration, the pus being discharged into the bladder or into the rectum. An attack of pericystitis is usually accompanied with fever and pain which may be so severe as to produce retention of urine. Or, retention may be caused by pressure of the exudate either above the symphysis or to the side of the bladder, or posteriorly. Such an exudate may be felt through the rectum or vagina. It is characteristic of pericystitis that after the bladder has been emptied by a catheter the rounded swelling persists. The urine may have a fecal odor, or a peculiar odor resembling that of appendical pus and suggesting a direct connection

between the bladder and intestine. If such a communication does exist, the urine will contain fecal matter, and there will sometimes be gas in the bladder. Such a condition may also be found after rupture of a prostatic abscess into the rectum. The bubbles of gas passing through the prostate into the prostatic urethra find their way through the weakened sphincter into the bladder.

The symptoms of diphtheritic cystitis are disturbances of function, such as dysuria and tenesmus, hæmaturia, and pain which frequently extends upward to the kidney. The urine is ammoniacal and often contains blood, pus, and epithelial cells and the products of inflammation. Fragments of tissue are often passed with the urine, and may lodge in the urethra and require removal by instruments. Such masses, while not obstructing the bladder, may so clog its lumen that aspiration of the bladder is necessary.

Tuberculosis of the bladder in its early stages is marked by tenesmus and a tendency to hemorrhage from the neck of the bladder. Sometimes the amount of this hemorrhage is alarming, and it continues for a long time in spite of absolute rest. Such a hemorrhage is repeated from time to time until the bladder passes into a state of catarrh. Tenderness and pain are greatly increased as the disease progresses and the tenesmus becomes very troublesome. Fever is wanting, or, if present, depends upon the accompanying inflammation.

If the tuberculous bladder is palpated from the rectum, there will be noticed swelling and tenderness of the prostate gland, seminal vesicles, and base of the bladder. The cystoscope will show the presence of ulcers, especially at the neck of the bladder, or, less often, nodules around the urinary openings or miliary nodules in other portions of the bladder. The course of the disease may be rapid, or it may continue for years.

The tubercle bacillus seems not to favor ammoniacal fermentation; hence the urine is usually acid, although in all other inflammatory states of the bladder it easily becomes alkaline. Tubercle bacilli in the sediment may be found by Gabbet's method. The dry preparation is immersed for five minutes in a solution of fuchsin 1 part, alcohol 10 parts, carbolic acid 5 parts, distilled water 100 parts. It is then rinsed, decolorized, and again stained for three minutes in a 1 per cent. solution of methyl-blue in a 25 per cent. solution of carbolic acid. It is again rinsed, dried, and mounted in Canada balsam. The tubercle bacilli will be stained red and all other parts blue. The bacilli are usually present in only small numbers. If none are found after examination by Gabbet's method, an attempt should be made to stain them by Ziehl-Neelson's or by Ehrlich's method.

The injection of small doses of tuberculin may be of service in establishing a diagnosis of primary tuberculous cystitis. If such an injection is followed by an increase of pain, tenesmus, and urinary

sediment, the diagnosis of tuberculosis is probable. In some cases a reaction follows the second or third injection within a short interval if it does not follow the first. Whenever there is vesical catarrh, without obvious cause, which has lasted a long time, and constantly recurs, one should think of tuberculous cystitis.

Prophylactic Treatment.—Prophylaxis plays an important part in the treatment of cystitis on account of the necessary passage of the catheter. This instrument should be disinfected with the greatest care. A glass female catheter has the advantage that one can easily see whether or not it is clean. Metal catheters are also easily disinfected. These instruments should be sterilized by boiling water or

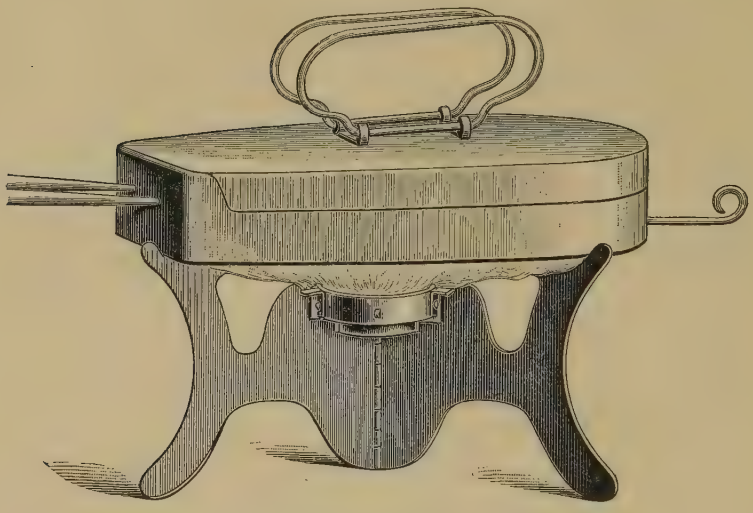
FIG. 191.

Aseptic catheter, all surfaces rounded. (Zuckerkandl.)

steam with the same care as instruments for surgical operations. The elastic and soft rubber catheters are more difficult to sterilize. Fortunately many of these instruments cost so little that a new catheter can be provided for each patient and also whenever through use one loses its smooth surface. A catheter of this sort ought to have a solid tip. (Fig. 191.) These soft catheters are injured by prolonged boiling, so that they should be sterilized by steam, or if placed in boiling water they should be taken out in a few minutes. (Figs. 192 and 193.) But the best method of disinfection is by formalin gas. A dried tablet placed in the bottom of the cylinder will generate sufficient gas. Unfortunately the sterilization requires several hours, and the formalin clings to the instrument and may irritate the urethra. Hence it is necessary to wash the catheter with boiled water before it is used. Such instruments may also be sterilized in a solution of mercuric chloride 1 : 1000, or a solution of carbolic acid. Silk catheters should be washed with alcohol to free them from fat before they are placed in the sublimate solution, or in a solution of nitrate of silver 1 : 2000. They should be washed with sterile water before they are used.

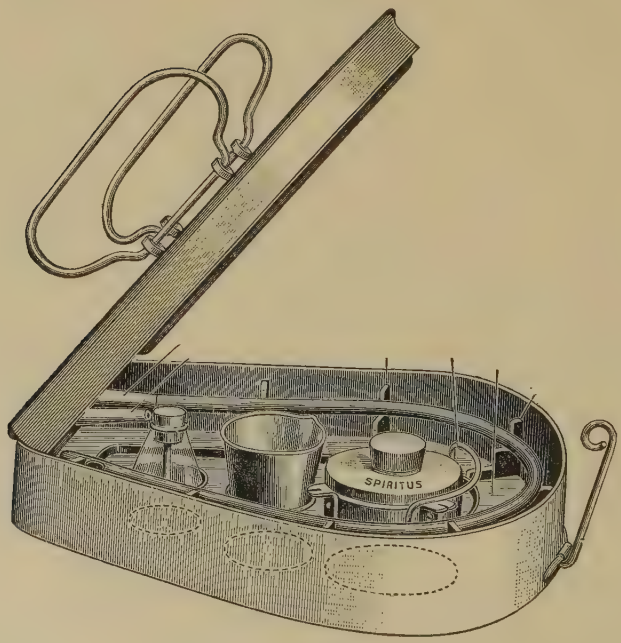
The lubricant should be sterile. Glycerin, paraffin oil, boroglycerin, lanolin, and olive oil are all suitable for this purpose. Lubrichondrin and similar preparations of Irish moss are much employed in America as lubricants. They contain no fat, mix easily with water, and are very slippery, like normal mucus. If an oily lubricant is employed, it can be heated in a test-tube placed in boiling water and then cooled immediately before use. The urethral orifice should be cleansed with a 1 : 1000 bichloride solution. After the

Fig. 192.



Rupprecht's catheter sterilizer. Closed.

Fig. 193.



Rupprecht's catheter sterilizer. Open.

catheter is used, it should be washed with soap and rinsed with warm water.

Even when the greatest care is employed, it is still possible for the bladder to become infected by the use of a catheter. Most of the germs which may cling to it from the air are harmless; but pathogenic bacteria are not infrequently found in the urethra, and may be carried by the catheter into the bladder. If under such circumstances the urine contains abnormal elements, for example, albumin, germs may develop in it even though they could not do so if the urine were normal. Without some such favorable soil the common agents of inflammation (bacterium coli, staphylococcus, streptococcus) would be powerless to excite cystitis. The proteus bacillus, however, seems to be able to develop and injure a healthy bladder if it remains in it for a short time.

A further object of prophylaxis is to overcome, or minimize, a diseased condition which favors the development of cystitis. This includes the removal of a vesical calculus, the treatment of urethral stricture, etc.

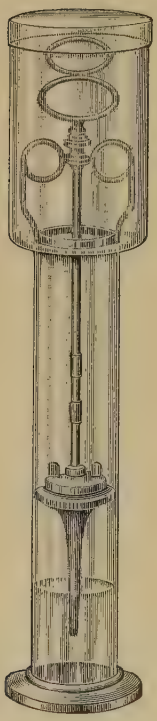
Medical Treatment.—Internal medication may be of great service. Every patient with cystitis can best be treated in bed, and this rule is even more important if fever exists. The warmth of the bed lessens tenesmus. If the patient refuses to go to bed, he should be protected from the harmful influences of cold by warm clothing about the abdomen and lower extremities. Warm baths, or sitz baths with aromatic herbs, help to relieve him of the tenesmus. If the patient remains in bed, hot moist compresses may be kept upon the abdomen. Tea made of mild diuretics should be frequently administered, or warm milk, or milk diluted one-half with carbonated beverages. The diet should be plain and the quantity limited. If the tenesmus does not disappear with this treatment, it will be necessary to administer narcotics. For this purpose a few drops of the tincture of opium will suffice. It is well to avoid large doses of opium on account of the constipation it produces. For this reason morphine is preferable to a large amount of opium. The great quantity of fluid given to the patient will not lessen the frequency of micturition, but will make the act less painful.

Rostroski found that the more acid urine is the more difficult it is for the bacteria which excite cystitis to develop in it. He therefore advocates the administration of such drugs as will increase the acidity of the urine. Of the newest remedies which have been employed in the treatment of cystitis, protargol has proved itself of the greatest value. It is a powerful antiseptic which does not irritate in acute cystitis, and which may be used with advantage in chronic cystitis in case nitrate of silver is too painful to be borne.

In the acute stage of cystitis it is all-important to recognize and overcome the cause of the difficulty. If the cause is not clear, it is better not to begin with local treatment, but to reserve this until a minute history, a physical examination, and if possible a cystoscopic examination, have positively indicated the cause of the trouble. In

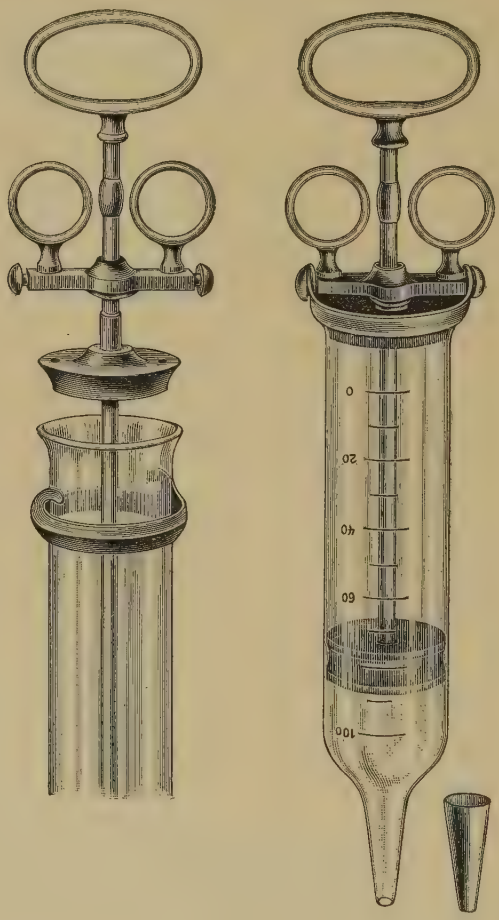
many cases the best form of treatment is to overcome the intense pain which exists. Any dilatation of the bladder under such circumstances increases the pain; hence irrigation is positively counter-indicated; or if any fluid is introduced into the bladder its quantity should not exceed a few drops.

Fig. 194.



Dust-proof glass cylinder for holding syringe. (Zuckerkandl.)

Fig. 195.

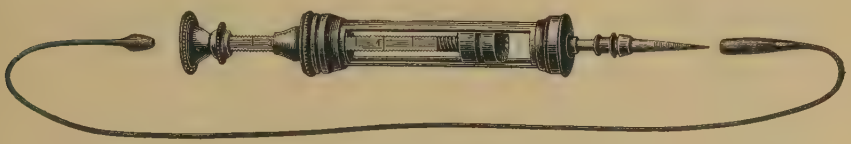


Guyon's bladder syringe.

Guyon's plan is to inject a few drops of a 2 per cent. solution of nitrate of silver into the bladder immediately after urination. He uses a graduated syringe and a small soft rubber catheter with an olive tip. Not more than 20 drops of fluid are injected into the bladder. (Figs. 194, 195, and 196.) This injection causes a marked increase of pain and often produces evacuation of urine and feces. It is followed by intense heat in the bladder and rectum. These

symptoms subside in from three to six hours, although an increased tenderness of the bladder is noticeable for a day or more. The injection should not be repeated until all signs of increased irritation have disappeared. This treatment by instillation is applicable in all forms of cystitis with the exception of the tuberculous. Its good effects are most promptly seen in cases of cystitis due to catheterization or made worse by catheterization. In cases of gonorrhœal cystitis the good effect is far less marked.

Fig. 196.



Guyon's syringe, one-half natural size.

Operative Treatment.—In the worst cases of cystitis in which tenderness of the bladder is very great and the organ is so firmly contracted that local treatment is useless, an operation is indicated. Cystotomy gives the organ complete rest, since the urine flows through the wound as soon as it enters the bladder. Such an operation is also of benefit in the diphtheritic and gangrenous forms of cystitis, and should then be followed by regular irrigation with boric acid or salicylic acid solution. If in membranous cystitis the membrane does not break up and come away, or if irritability of the bladder increases, or hemorrhage occurs, it is of great advantage to open the bladder and inspect directly its diseased mucous membrane. According to circumstances, it may be curetted and touched with a 10 per cent. solution of nitrate of silver or with a Paquelin cautery. Such a bladder should not be closed again for several weeks. Drainage of the bladder is indicated in obstinate and severe cases of cystitis whether acute or chronic. This treatment was practised as long ago as the eighteenth century by Collot. In recent times it has been developed by Simon and Thompson. Thompson preferred peritoneal section on account of the small risk which is involved, and because he believed the bladder to be better drained if the opening is made in its lowest part. This is a mistake, as shown by further experience, and especially so in those cases in which there are diverticula. Hence the practice to-day is to make the incision suprapubically whether the cause of cystitis is a calculus or foreign body or a new growth, or enlargement of the prostate. This operation also obviates repeated difficult catheterization and facilitates local treatment of the mucous membrane. The risk of septic infection following such an operation can be minimized by the use of permanent irrigation. Two bent glass or hard rubber tubes are inserted through the wound into the bladder. One of them is

connected with a receptacle containing a solution of boric acid elevated above the patient, while the other one leads into a vessel under the bed. In a few days the planes of tissue which have been divided adhere so that there is no longer risk of infiltration of urine or infection. The permanent irrigation may then be done away with. Other surgeons prefer to keep the bladder empty by siphonage.

In opening the bladder suprapubically it is of advantage to have the patient's pelvis elevated so as to avoid wounding the peritoneum, and to obtain a direct view into the bladder. Whether the incision should be made longitudinally or transversely depends upon the object for which the operation is performed. If merely a small opening is to be made into the bladder, it is better to make the incision longitudinally. Such an incision does less injury to the surrounding tissues and heals more quickly. On the other hand, if there is to be extensive treatment of the mucous membrane of the bladder, a transverse incision gives freer access and therefore has the advantage over the longitudinal one.

Guyon insists on filling the bladder before making the operation, and advises against operation in cases in which the bladder will retain no fluid. Without doubt this preparation simplifies the operation. The best fluid to use is a warm 4 per cent. solution of boric acid, of which 150 to 200 grammes may be injected. Helferich distends the bladder with air. Still, in case of necessity, one may dispense with distention of the bladder if a sound is passed into it through the urethra in order to act as a guide.

In making the transverse incision the skin, fat, fascia, and recti and pyramidal muscles are divided by an incision 10 to 15 cm. (4 to 6 inches) in length just above the symphysis pubis. The loose fat which fills the prevesical space is pushed upward with the reflection of the peritoneum, thus exposing the anterior wall of the bladder. If threads are inserted into the bladder-wall, the viscus may be drawn further forward into the wound and incised transversely. If it is desired to keep up the drainage of the bladder for a long time, it is well to stitch the cut edges of the bladder into the superficial wound. As soon as the operation is completed, the bladder should be irrigated with warm boric acid solution and nitrate of silver. This can be done while the patient is still under the anæsthetic. If the silver solution is used, any surplus should be washed away with a normal salt solution. Some surgeons prefer to cauterize ulcers or other lesions of the mucous membrane with a Paquelin cautery. If it is not intended to irrigate the bladder afterward, no gauze or rubber drainage is necessary. Later, when the wound shows a tendency to close, a small metal or rubber tube may be left in it. Suprapubic cystotomy not only gives the surgeon a good chance to inspect the bladder, but it affords the organ complete rest for several weeks. In cases in which suppuration of the bladder repeatedly occurs, and in which on account of contraction and pain it is impossible to irrigate

satisfactorily, cystotomy is the only method of treatment which is worth considering. It is easy to cleanse the bladder through a fistula. This is even accomplished by a sitz bath. The patient suffers a good deal in the first days after operation unless he lies continuously on the side. These pains soon pass off and the patient leaves the bed wearing a tube through which he may pass urine from time to time. In-between times the tube is stopped with a cork. Such a tube should be worn constantly by a patient in whom permanent drainage is desirable. In operating under such conditions the surgeon is advised to make an oblique fistula similar to the fistula

FIG. 197.

Showing manner in which the bladder may be displaced in a very fat patient. (Delbet.)

made in Witzel's gastrostomy. If this measure succeeds, the patient will be able to go about without a permanent tube, simply passing an elastic catheter through the fistula when he desires to empty the bladder. One of the results of chronic cystitis is the development of a contracted bladder. The unfortunate patient is then compelled to wear a receptacle on account of the almost constant flow of urine. One may attempt to empty the bladder by gradually increasing injections, but this treatment often fails to accomplish the desired end.

In order to establish a vesicovaginal fistula the patient is placed in the lithotomy position. This posterior vaginal wall is pressed

well backward with a speculum and a stone-searcher or sound with a large curve is passed into the bladder and made to protrude into the vagina. The incision is made upon this instrument. The cut begins just back of the urethra and extends for a distance of 4 cm. (1.6 inches) exactly in the median line, so as to avoid wounding the ureters. A drainage-tube should be left in position for some days unless the discomfort caused by it is too great. Guyon performs this operation after injecting a 10 per cent. solution of nitrate of silver into the bladder. To dilate the neck of the bladder in the hope of bringing about a complete evacuation has proved fruitless. The bladder does not empty itself completely and the residual urine irritates and causes pain, just as much as when the organ is filled to a greater degree.

Treatment of Chronic Cystitis.—The whole life of a patient who has chronic cystitis should be carefully regulated. A patient who has suffered for years from acute exacerbations of vesical catarrh is easily made worse by exposure to cold and wet, by excesses in eating, riding, travelling, etc.

Among dietetic cures the milk cure and the whey cure have much to recommend them, provided the stomach is able to bear such a diet. The free use of mineral waters is also advisable unless the condition of the patient's heart contraindicates. Sulphur baths and salt baths are used with benefit, but they should, of course, be combined with local treatment. Internal remedies are not of much service. The writer has not been favorably impressed with the use of salicylic acid even in doses up to 10 grammes ($\frac{1}{3}$ ounce) a day, or of salol, or of the newer remedy urotropin. These medicines are not well borne except for a short time, and have seemed to do good only when first administered.

Thus, in chronic cystitis local treatment is the most important part of the treatment, and this applies especially to irrigation of the bladder. Before beginning the irrigations it is well to see what benefit may follow regularly and carefully performed catheterization. It is well to remember that the pus and mucus on account of their density settle to the lowest position of the bladder, so that they are neither removed by voluntary micturition nor by the catheter. Therefore in most cases catheterization must be supplemented by irrigation. There are three counterindications for irrigation of the bladder: namely, intense pain, acute renal disease, and acute inflammation of the urethra. The principal object in irrigating the bladder is to remove all the collected pus and mucus and inflammatory products. This has not always been accomplished as soon as the water returns clear. Examination with the cystoscope after a thorough irrigation will show that even in a bladder of normal dimensions there remain a great number of particles of mucus and pus. This is especially true if irrigation is carried out in a recumbent position. If the bladder is abnormally large and is irrigated

when the patient is lying down, the quantity of material which remains after irrigation is much greater, and a good deal will remain even after irrigation when the patient is sitting or standing. This proves that the good effects of irrigation are only obtained little by little, and, furthermore, that the proper performance of the act is not so simple as it first appears, and that the position of the patient and the manner of introduction of the stream are of considerable importance.

Technic of Irrigation.—A soft catheter measuring No. 16 to 18 French is chosen. Even after lithotrity it is better not to use a catheter larger than No. 25 French, and No. 21 French will usually suffice. Metallic catheters are useful to wash out the fragments of a calculus after the stone has been crushed. Such a catheter may be either straight or slightly curved. A double-current catheter is not to be recommended because the calibre of the two canals is of necessity so much reduced. It is well to employ a soft catheter with two eyes so that two streams of water flowing in different directions at the same time may wash out more actively the base of the bladder. Guyon and Ultzmann use a syringe for injection of the fluid. If the syringe works easily, it has the advantage that one is conscious of the amount of resistance made by the vesical wall and so can avoid placing too great strain upon it. If the patient performs the irrigation, a fountain syringe is much more convenient. In truth, this method of irrigation is the one commonly employed by surgeons as well as by patients. The receptacle containing the fluid should be of glass so that it can be easily cleansed, and have a scale marked upon it so that the surgeon may know how much fluid has entered the bladder. The connection between the catheter and the tube of the irrigator should be made by a hard rubber tube having a stopcock. The irrigation should not be made when the patient is standing lest the abdominal pressure and the weight of the abdominal organs prevent the entrance of much fluid into the bladder. Furthermore, the catheter is more easily obstructed when the patient stands. He should lie in bed with the hips elevated upon a firm cushion. The bladder should be emptied by the catheter and then slowly distended with the injecting fluid warmed to the temperature of the body. As soon as the patient complains of pain, or the resistance to the flow of fluid is increased, the injection should be stopped and the fluid in the bladder allowed to flow out. The injection is then repeated as often as may be necessary. It is better not to allow the bladder completely to empty itself between the injections. If it does so, the bladder-walls contracting upon the end of the catheter are irritated and may bleed. One should avoid injecting air into the bladder, although this is not a serious mishap. When the fluid returns perfectly clear, the irrigation may be stopped. The quantity which the bladder will receive at one time is usually small—from 60 to 150 c.c.

(2 to 5 ounces), whereas the normal capacity of the bladder in health is from 200 to 400 c.c. (6 to 13 ounces). If the bladder contains blood-clots, a simple irrigation is not sufficient to remove them. It will be necessary to aspirate with the help of a syringe.

It is usually unwise to attempt to dilate the bladder by means of the irrigator. It was formerly supposed that antiseptic fluids would have the best curative effect upon a bladder in which the urine has undergone ammoniacal decomposition as the result of bacteria. Experience has shown this to be only partially true, and an attempt should be made by means of irrigations not merely to destroy the bacteria, but also to overcome the cause of the cystitis. The best remedy for this purpose is nitrate of silver. It has an antiseptic action and favors repair of the mucous membrane. It may be used at first in a strength of 1 : 2000, and this strength can be gradually increased until 1 : 500 is reached. An injection of nitrate of silver should always be preceded by one of a normal salt solution, or boric acid solution, in order to cleanse the bladder and to facilitate application of the remedy to all parts of the mucous membrane. Before injecting the nitrate of silver the catheter should be partly withdrawn so that the prostatic portion of the urethra may share the irrigation, since it is almost always affected by the catarrh. The fluid is left in the bladder for two or three minutes, and then the patient is allowed to pass it spontaneously. If the bladder is very sensitive, the irrigation of nitrate of silver may be followed by an irrigation with a salt solution. The injection of nitrate of silver may be repeated every few days. In all cases in which the bladder is not inflamed the normal salt solution (0.8 per cent.) or 4 per cent. solution of boric acid, or 0.3 per cent. solution of salicylic acid should be employed.

Some surgeons make use of much stronger solutions of nitrate of silver than those here recommended. But they are likely to cause symptoms of severe irritation. When employed, the quantity used should be very slight, and injected with a small syringe. (Fig. 196.) Such instillations are recommended by Guyon in a form of disease known as cystitis dolorosa, in which the bladder is permanently and painfully contracted. This condition is often brought about by too vigorous irrigation.

The operative treatment of chronic cystitis has been indicated in connection with acute cystitis.

A great number of substances have been recommended for use in irrigation of the bladder, such as resorcin in 0.5 to 1 per cent. solution, sulphate of sodium in 5 per cent. solution, permanganate of potassium, etc. Solutions of bichloride of mercury and carbolic acid are dangerous and should not be employed. Some surgeons speak highly of a decoction of cocoa leaves with boric acid (15 to 20 grammes of cocoa leaves, 500 grammes of water, a few drops of hydrochloric acid, and 10 grammes of boric acid). Sulphate of

zinc and sulphate of thallin have been used to overcome inflammatory hypertrophy of the mucous membrane, but they are inferior to nitrate of silver.

Sometimes the best local treatment by irrigation fails to improve the condition of the bladder. Such is the case in certain forms of paralysis, and certain forms of hypertrophy of the prostate, and also in cystitis which is associated with constant suppuration, occasional hemorrhage, and so much pain that the strength of the patient is exhausted. Under these circumstances the bladder should be opened and drained.

Some writers advocate simple drainage of the bladder, with or without abundant irrigation. The writer does not advocate such drainage, although cases of dilatation of the neck of the bladder from disease seated in the posterior portion of the urethra are eventually cured by it. However, the bladder can be drained just as well by a soft catheter introduced through the urethra as by one introduced through the perineum.

If a pericystic abscess exists, it should be opened at once, preferably through the rectum.

The treatment of a contracted bladder is most tedious. Dilatation of such a bladder should be attempted only in the case of a fairly robust patient. Even then it does not always succeed. It is dangerous to dilate a bladder forcibly when the patient is anæsthetized.

In order to carry out the practical purpose of this surgery it is worth while to insert here a brief statement of the commonest kinds of cystitis—that is, cystitis due to tuberculosis, to gonorrhœa, to urethral stricture, to hypertrophy of the prostate, to calculus, and to tumor of the bladder.

Tuberculous Cystitis.—The local treatment of tuberculosis of the bladder is ineffectual. Much depends on internal treatment to combat disease and to relieve pain. Such remedies as creasote, guaiacol, and balsam of Peru have little effect either upon the vesical pain or the vesical catarrh. Saline baths may be employed with benefit. Numerous attempts have been made to open the bladder so as to treat directly the diseased mucous membrane, but this practice has proved unsuccessful, and has been generally given up. The results of instillation are equally unsatisfactory. Certain writers recommend the use of chloride of zinc for local treatment in this manner. At the recent International Congress held in Paris surgical treatment of tuberculosis of the bladder was advocated, and several surgeons expressed themselves in favor of opening the bladder in order to remove the diseased tissue with the curette and thermocautery. Suprapubic cystotomy was also proposed as a measure to relieve intense pain. It must not be forgotten, however, that some patients with tuberculosis of the bladder have been markedly improved or cured without operation.

Cystitis following Gonorrhœa.—Cystitis may develop a long

time after acute gonorrhœa, but a causal relation between the two can nevertheless be made out. When gonorrhœa becomes chronic, its seat is especially in the posterior portion of the urethra, and a patient in this condition is constantly exposed to the risk of gonorrhœal cystitis. Such a cystitis may also arise in the period of free urethral discharge, that is to say, in the third or fourth week. If it appears in the first few days of an acute gonorrhœa, it is due either to the use of a catheter or to a careless injection. For example, if one injects too much fluid into the urethra, that is to say, more than 4 or 5 c.c., the force of the injection may overcome the contractile power of the sphincter, and the fluid, together with the gonorrhœal pus, may be driven into the bladder. Gonorrhœal cystitis may also be produced by excessive muscular action, by alcoholic drinking, by coitus, etc. The portion of the bladder which is especially inflamed in gonorrhœal cystitis is the neck of the bladder and its immediate vicinity. Under certain circumstances the disease may extend to the bladder in a late stage of the gonorrhœa—the so-called post-gonococcal stage. If the bladder becomes affected earlier, it is easier to demonstrate the presence of the gonococcus in the vesical contents.

Symptoms.—The symptoms of gonorrhœal cystitis may be either severe or slight. In severe cases micturition is frequent and painful and there is much tenesmus. The patient suffers from an almost continuous desire to urinate, which is most painful if the compressor urethræ muscle affords the slightest obstruction to the discharge of urine. A patient in this condition must urinate every five minutes, and each act produces intense pain. He strains almost to the point of collapse, and produces only a small quantity of urine, the last few drops of which are usually bloody. In the course of a gonorrhœal cystitis retention of urine may develop on account of spasm of the sphincter. This may be so well marked that it is impossible to pass a soft catheter. On the other hand, there may be incontinence, as it is mistakenly called, for there is not really an involuntary discharge of urine, but an almost constant desire to urinate, so that the patient is unable to retain any urine in his bladder. Gonorrhœal cystitis is accompanied with fever only in case the prostate gland or the kidneys are simultaneously inflamed. Sometimes the disease passes over in a few days, sometimes it lasts for a week. There are also many patients in whom the disease either becomes chronic or who suffer from recurrent attacks. This misfortune chiefly befalls ill-nourished or otherwise weakened patients. Guyon recommends instillation of nitrate of silver for these and other chronic forms of the disease. He says that this remedy acts so promptly that in doubtful cases it can be used to make a differential diagnosis between gonorrhœa and tuberculosis. In the latter disease it is either without effect or it acts injuriously. The earlier an instillation can be made, the better its effect. In

chronic cases it must sometimes be supplemented by irrigation of the bladder. Treatment should not be abandoned too soon, on account of the danger of recurrence.

Cystitis due to Stricture.—Experience shows that narrow and extensive resistant strictures predispose to cystitis. One reason for this is that under such circumstances the bladder becomes gradually dilated so that it does not completely empty itself. If, in addition to this dilatation, there is a compensatory hypertrophy of the muscular structure, the patient will appear to pass urine as well as ever; and yet all the while a functional insufficiency will develop which will be more marked the longer the stricture exists. And even before the bladder dilates it shows an increased vascularity on account of the extra work which it has to do, and this is a predisposing cause for the development of the catarrh. When the bladder is in such a condition, the irritation due to a simple catheterization, or to excesses in drinking, etc., may be sufficient to set up a cystitis. It may also be produced by leaving a catheter in the bladder after urethrotomy, or by a catheter left in the urethra for the purpose of dilatation. Such a cystitis presents no unusual symptoms. The diagnosis must be made from the character of the urine, since there is little or no tenesmus, certainly not more than can be produced by the stricture itself. In such a case separation of the first from the last portion of the urine is a help to diagnosis. If the portion first passed contains considerable pus, while the rest is cloudy or even clear, it is evident that most of the pus is washed from the posterior portion of the urethra by the urinary stream. If the pus exists only in the first portion of the urine, it is certain that there is no cystitis. If the latter portion of the urine also contains pus, the bladder is affected. The urine often has an ammoniacal reaction in cystitis due to stricture. The imperfect emptying of the bladder is the reason for this.

As the cystitis is due to stricture, it disappears in a short time if the stricture is relieved. It is therefore benign in character, and requires no especial treatment. The character of the urine improves, and its reaction becomes acid soon after the stricture is cured. The cases in which a chronic cystitis continues after relief of the stricture are rare. Hence treatment should be directed to a restoration of the urethra rather than to the bladder.

Cystitis due to Hypertrophy of the Prostate.—As a rule patients with hypertrophy of the prostate suffer from catarrh of the bladder. This is due not only to the obstruction to the passage of urine, but also to the senile changes in the bladder itself. There is usually arterial sclerosis. The bloodvessels having lost their elasticity do not permit a sufficient circulation of blood, and also interfere with the proper contraction of the bladder. There may be a partial or complete retention of urine. This may be brought about by resisting the desire to urinate for too long a time, by overstraining

while passing water, etc. Cystitis is often produced in these patients by the passage of a catheter.

In the majority of these cases the cystitis begins very gradually. The urine is at first somewhat cloudy and there is a little tenesmus without pain. The cloudiness of the urine increases; the acid reaction disappears; the urine begins to have a strong odor and deposits a sediment, and the act of urination becomes painful. It is at this stage of the disease that a calculus may easily develop in the bladder. There are also cases in which the disease begins more acutely, so that it may be necessary to pass a catheter to relieve the patient within a short time after the cystitis begins. Urination is very painful and the amount of pus in the urine is considerable. The inflammation may rapidly extend to the kidneys, and such a patient may die within a short time. Such a termination is the exception, and is seen only in neglected or severe or long-standing cases. As a usual thing the acute catarrh passes into a chronic one. Acute attacks of this character may also occur in the course of a chronic cystitis.

Treatment will depend upon the condition of the bladder. If the organ is able to empty itself completely, the inflammation will readily yield to treatment. The patient should be kept quiet and given either morphine or opium to relieve the pain. Under the influence of these drugs urination will become less frequent and the bladder will have more rest. Atropine is also recommended. For such mild cases internal treatment suffices. As long as the bladder empties itself completely catheterization is unnecessary, and irrigation of the bladder is not indicated. When the bladder is no longer able to empty itself completely, irrigation should be begun. This should be carried out at first with a mild solution, such as normal salt solution or boric acid solution, and if this does not allay the inflammation irrigation with nitrate of silver solution may be tried. If there is still no improvement, it will be necessary to open and drain the bladder suprapubically.

Cystitis due to Calculus.—It makes a difference whether a calculus enters the bladder from the kidney or whether it develops in the bladder itself. In the former case cystitis does not appear until the stone has been in the bladder some time, and, indeed, it may not develop at all. Furthermore, it disappears as soon as the stone is removed. On the other hand, if a cystitis exists, as, for example, as a result of prostatic hypertrophy, a calculus may form in the bladder secondarily to the cystitis. As a rule the mere removal of such a stone will not cure the cystitis, which requires its own special treatment. Even a calculus which comes from the kidney is a constant source of irritation to the bladder, and must be looked upon as a predisposing cause of cystitis. If at any time the patient undergoes severe muscular exertion or rides a long distance over a rough road, the calculus may be dislodged and shifted about

in the bladder and so set up an acute cystitis. Such an attack is likely to subside with rest. Such a patient may ordinarily have acid urine which easily becomes ammoniacal under the influence of overexertion. The symptoms disappear during a period of rest, and recur when the patient resumes an active life. Thus one attack follows another. The diagnosis of the disease is simple, and it is usually possible to say whether the cystitis or calculus is the primary condition. The first object of treatment is the removal of the stone; but if the cystitis is primary, treatment must not stop here, but must be continued until the cystitis is cured, even though suprapubic cystotomy and drainage are necessary.

Cystitis due to Tumors of the Bladder.—An inflammation of this character is most difficult to treat. The presence of a tumor in the bladder is of itself merely a predisposition to cystitis. Many such tumors lead to congestion of the mucous membrane and wall of the bladder, and thus predispose to catarrh. The symptoms vary according to the situation of the tumor. If it is in or near the neck of the bladder, it may obstruct the passage of urine. According to Thompson, pain is an early symptom of a malignant tumor of the bladder, while a benign tumor is early marked by hæmaturia, but not by pain. This statement is disputed by others. If the bladder contains a tumor and is therefore predisposed to cystitis, catheterization exercises an unfavorable influence upon it. Still, a catarrh of this sort does not of necessity become chronic, as is shown by repeated cystoscopic examinations, and the advice of Guyon not to pass any instrument until the patient is anæsthetized is certainly extreme. In all such cases cystoscopic examination should be made early in order that the cause of the cystitis may be recognized and properly treated. If the tumor is one which can be removed, the cystitis will speedily disappear. If the tumor is inoperable, a suprapubic incision should be made in order to relieve the patient.

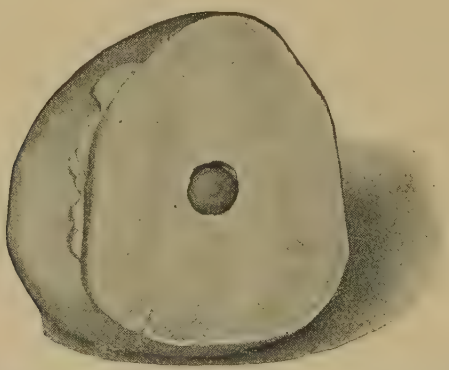
VESICAL CALCULI.

Calculi usually found in the urinary bladder are divided, according to their chemical composition, into uratic, oxalatic, phosphatic, and cystin calculi. Uratic calculi may consist of crystallized uric acid, or of urates. Oxalatic calculi are composed of calcium oxalate. Phosphatic calculi contain crystalline and amorphous calcium and magnesium phosphates; also ammoniomagnesium phosphate and traces of ammonium urate. Calculi composed of cystin are rare, never reach a large size, and are for the most part formed of pure cystin. Calculi composed of indigo and cholesterin and xanthin, etc., are pathological curiosities.

Most of the substances of which calculi are composed are found in varying amounts in normal urine. Ammoniomagnesium phos-

phate and ammonium urate occur only in urine which has undergone ammoniacal fermentation. The first requisite for the formation of a calculus is the deposition of some of the above mentioned salts. This takes place when the chemical substance is present in the urine to an abnormal amount, or when the composition of the urine is somewhat altered; for instance, when it is too acid or alkaline. But the deposition of these substances of itself is not sufficient for the formation of a calculus, since there are patients who pass particles with their urine constantly, but in whom no calculi form. The second requisite for the formation of a calculus is the presence in the bladder of some object around which the salt shall be deposited. Small renal calculi from the beginning become in this

Fig. 198.



Calculus of the bladder in cross-section to show the nucleus of uric acid which entered the bladder from the kidney and the outer coating of phosphates formed in the bladder itself.

manner the nuclei of vesical calculi. (Fig. 198.) In a small number of cases a calculus forms about some foreign body which has made its way from the outside of the urinary passages into the bladder.

In some cases blood-clots become incrusted in the bladder. Bits of mucus and shreds of tissue are common nuclei for the formation of vesical calculi, and this explains the facility with which calculi form in the presence of vesical catarrh. In tropical countries the eggs of distoma hæmatobium enter the bladder and give rise to calculi. Filiaria sanguinis may act in the same manner.

Epstein and Posner have shown that every urinary calculus, no matter what its size, contains a delicate organic framework in which the various salts are deposited. Thus, a calculus is a complicated structure, and not a simple crystallization or a conglomeration of deposited salts.

Calculi composed of uric acid, oxalic acid, and cystin, are formed only in the kidney, whence they may proceed to a bladder to become the nuclei of larger calculi. Phosphatic calculi may also form in

the pelvis of the kidney, in which case they are usually made up of crystalline calcium phosphate. But the vast majority of phosphatic calculi are formed in the bladder in the presence of cystitis. They may be composed of the normal earthy salts of the urine, or of the ammoniomagnesium phosphate—the so-called triple phosphate.

Few calculi are composed of only one substance. Most contain several. On cross-section different substances are often clearly shown to exist in layers. The explanation for this formation is that as the reaction of the urine varies so will vary the particular salt which is deposited.

A calculus subjected to chemical analysis should be sawed through in the middle. If its structure is uniform throughout, the sawdust may be used for analysis. If the structure varies, a little powder should be scraped from each concentric ring with a pointed knife. The details of such analysis are given in books on chemistry, but Ultzmann's table is of such practical value that it may well be given here.

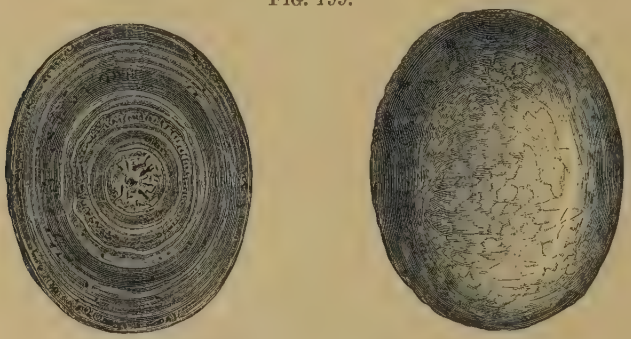
Combustible.	The powder burns without a visible flame, and without odor.	The murexid test with ammonia is purple red, with caustic potash purple violet.	Uric acid and urates.
		The murexid test with ammonia is yellow, with caustic potash orange.	Xanthin.
	The powder burns with a feeble blue flame, and with an odor like burning sulphur and fat, or asafœtida.		Cystin.
Non-combustible.	The powder effervesces with hydrochloric acid.		Calcium carbonate.
	The powder does not effervesce with hydrochloric acid.	The powder effervesces after it is heated.	Calcium oxalate.
		The powder does not effervesce after it is heated.	Earthy phosphates.

Microscopical examination of different sections of a calculus is most interesting. Such sections should be made parallel to the long axis of the calculus, and should be sufficiently thin to permit of examination with lenses which magnify 300 diameters.

A vesical calculus may be single, or many calculi—even a hundred or more—may exist at one time. They vary in size from the smallest particle to the size of a hen's egg or larger. Deschamp described one which weighed 1593 grammes (53 ounces). Very large calculi are usually solitary, fill the vesical cavity, and partake more or less of its shape. If the bladder is essentially normal, calculi contained in it are freely movable and shift their position without changes in the position of the patient. They can, therefore, increase in size in any direction, and their forms vary according to the substance of which they are composed. Uratic, phosphatic, and cystin calculi are flattened ellipsoids, having somewhat the shape of a long loaf of

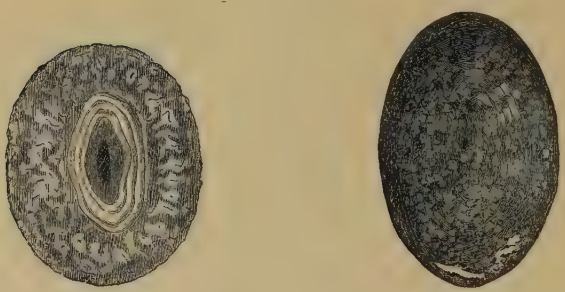
bread, while oxalatic calculi usually have the shape of a flattened sphere. (Figs. 199–203.) Calculi of the first three kinds mentioned have all three diameters different, while oxalatic calculi have two

Fig. 199.



Vesical calculus composed of uric acid (Natural size.)

Fig. 200.



Vesical calculus composed of urates. (Natural size.)

Fig. 201.

Vesical calculus composed of phosphates. (Natural size.)

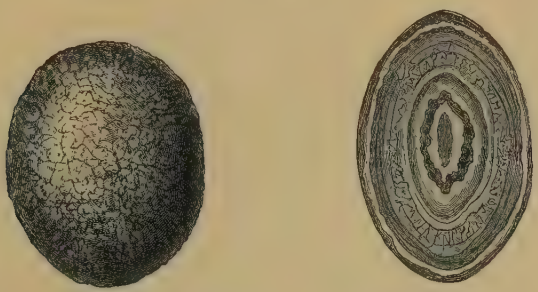
diameters essentially alike. Ultzmann says this difference is due to the difference in shape of the crystals, since those of uric acid, phosphates, and cystin are rhomboidal, while crystals of calcium oxalate are quadrates.

PLATE XVI.

Encysted Calculi of Bladder. (Taylor.)

If the development of a calculus is limited, its shape will, of course, be irregular. Thus an incrustation of a foreign body partakes, especially in the beginning, of the shape of such foreign body. If there are pockets in the base of the bladder, as is so often the case in elderly men, the shape of the calculus may conform to that of the pockets. If such a calculus increases until it completely fills a deep pocket, it may be immovably fixed in this situa-

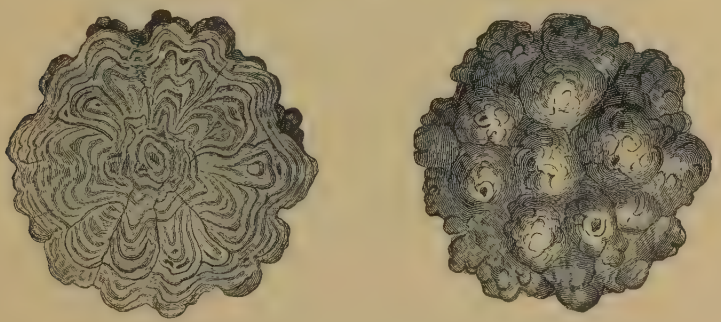
FIG. 202.



Vesical calculus composed of cystin. (Natural size.)

tion. In another case a calculus formed in the bladder may become incarcerated in a pocket, and, increasing in size, both within the pocket and within the bladder, present more or less the shape of an hour-glass. This also happens when a portion of the calculus is situated in the bladder, and a portion in the prostatic urethra. (Fig. 205.)

FIG. 203.



Vesical calculus composed of calcium oxalate. (Natural size.)

In rare cases calculi form in ulcers and are literally adherent to the wall of the bladder. This only takes place in severe ammoniacal cystitis.

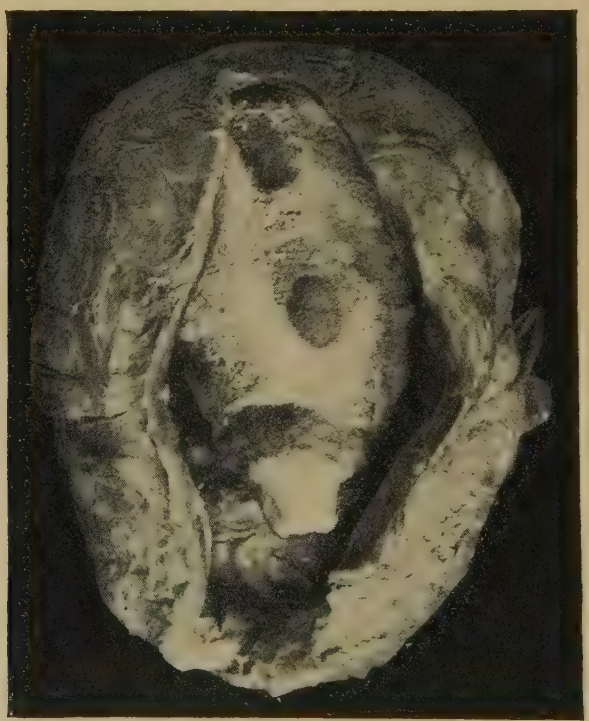
If the bladder contains several calculi, freely movable, they are more or less rounded. If they remain closely pressed together, their natural development will be interfered with and the different

calculi will have flattened sides where they lie in contact. These are spoken of as facets. (Fig. 206.)

The surface of a phosphatic calculus is smooth, that of a uratic calculus is either smooth or finely granular. An oxalatic calculus is often covered with large rough points which have won for it the name of mulberry stone. Sometimes a uratic calculus has a similar surface.

The color of a calculus depends upon the substance of which its outer layer is composed. Phosphates are almost as white as chalk unless an admixture of blood gives them a dark or even black color.

Fig. 204.



Very large vesical calculus and phosphatic crusts with chronic cystitis. (Taylor.)

Sometimes light and dark areas coexist on the surface of the same calculus. Uratic calculi are yellowish or brownish, and oxalatic ones are dark brown or black.

The softest vesical calculi are composed of cystin and phosphates. The former are about as firm as wax and are easily cut with a knife. Phosphatic calculi are as hard as chalk or a little harder. Uratic calculi are much harder than this, especially those composed of uric acid. The oxalatic calculi are the hardest of all, and those which are pure can scarcely be crushed with a lithotrite. Calculi

composed of different layers are for the most part readily crushed. The nucleus is generally harder than the outer layers.

Vesical calculi are rare in women, those which are found being chiefly due to incrustation of foreign substances. In Coulson's collection of cases 8 calculi were found in women and 395 in men. This is explained by the shortness and large calibre of the female urethra, which usually permit the passage of such

Fig. 205.

Vesical calculus whose shape suggests a Turkish pipe; formed partly in the prostatic urethra.

renal calculi as find their way into the bladder. In the male sex most calculi occur in infancy or after the fiftieth year. Those found in infancy form about renal infarcts, and then are promptly discharged. The frequent occurrence of calculi in advanced age is due to the decreased power of expulsion of the bladder and to a change in the shape of its base, so that renal calculi are less easily

Fig. 206.

Facetted vesical calculi.

discharged from the urethra. The preponderance of phosphatic calculi in old men is due to the frequency of cystitis among them.

There are certain families most of whose male members sooner or later suffer from vesical calculi. Certain diatheses have a predisposing influence. Thus those patients who suffer from diabetes and gout also suffer from vesical calculi to a greater degree than men who are free from these troubles.

Symptoms.—If one inquires into the history of a patient with a

vesical calculus, he will often learn that such a patient has passed small renal calculi for years, and has possibly suffered from attacks of renal colic. Symptoms due to a vesical calculus are extremely variable. The condition may exist for a long time without producing especial symptoms. If the surface of the calculus is smooth, there is plenty of room in the bladder, which does not contract with very great force as long as vesical catarrh is wanting.

The first painful symptom complained of by many patients is increased vesical tenesmus. Sometimes this occurs as a sudden desire to empty the bladder; sometimes at the end of micturition there is an unpleasant pressure and straining. Such symptoms are noticed only during the day, and are increased by bodily motions, riding over a rough road, etc. When the patient is quiet, and especially if he lies down, these symptoms wholly disappear. This fact is characteristic of a movable calculus. When the patient is quiet, the calculus rests quietly in the not very sensitive fundus of the bladder. When he moves about, the calculus is thrown against the more sensitive neck of the bladder. Sometimes the patient is able to recognize the motion of a calculus in his bladder. In rare cases a calculus during micturition comes against the internal urethral orifice, and, acting like a ball valve, suddenly stops the stream of urine.

Another important symptom is the admixture of blood with the urine, giving it a reddish tint. Larger hemorrhage is rare. Often there is a drop or two of bloody urine at the very end of micturition. This is due to a painful contraction of the empty bladder about the rough calculus. The pain is relieved as soon as urine again collects and separates the vesical wall from the calculus. Whatever hemorrhage there is, is increased by violent bodily motions, rough riding, etc.

Sometimes the patient complains of a burning or dragging pain in the head of the penis, and sometimes the effect of a calculus is greatly to stimulate sexual desire. Sometimes the head of the penis is abnormally sensitive, so that the patient cannot bear the slightest touch from the clothing.

The symptoms of vesical calculus may be endured for a considerable time, but as the calculus grows they are apt to increase in severity. But even then the pains disappear when the patient goes to bed. He has a restful sleep and wakes in the morning without symptoms, which return as soon as he goes about, and may become violent at the end of every micturition.

The symptoms of vesical calculus are far more severe if the calculus develops in a patient who suffers from cystitis, or if cystitis is produced by the calculus, as it may be by any calculus whose surface is rough. If bacteria find their way into a normal bladder, they are usually passed out with the urine. If they enter a bladder containing a calculus, they find a favorable soil for development, and soon

bring about cystitis. For this reason instrumental examination of a patient with a vesical calculus is apt to be followed by cystitis. The symptoms vary with the intensity of the catarrh, and are greatly increased by bodily motion, though they never entirely disappear even under the influence of rest. Frequency and urgency of micturition, pain during and at the end of the act, hæmaturia, etc., all exist in an intensified form. The constant straining may produce hernia or rectal prolapse. The urine is always cloudy and contains more or less blood.

If the patient is unable fully to empty his bladder on account of prostatic hypertrophy, the symptoms of vesical calculus are somewhat different. Then the calculus lies in a recess of the base of the bladder and does not shift its position on account of the bodily motions of the patient. The symptoms, therefore, do not vary much whether the patient is active or at rest, and since the bladder cannot fully empty itself there is no tenesmus or bleeding at the end of micturition. If the bladder is fully emptied with the catheter, the patient feels uncomfortably the contact of the vesical wall with the calculus. Such a patient sometimes complains of pain in the anal region, due to the incarcerated calculus. In general, however, the symptoms are slight as long as there is no vesical catarrh, so that a calculus may exist for years before relief is looked for. As soon as cystitis develops, the symptoms become very severe. There may be unbearable constant tenesmus, great pain with micturition, sleeplessness, etc.

A calculus which is situated partially in the prostatic urethra produces symptoms similar to those of urethral stricture. There may also be incontinence of urine.

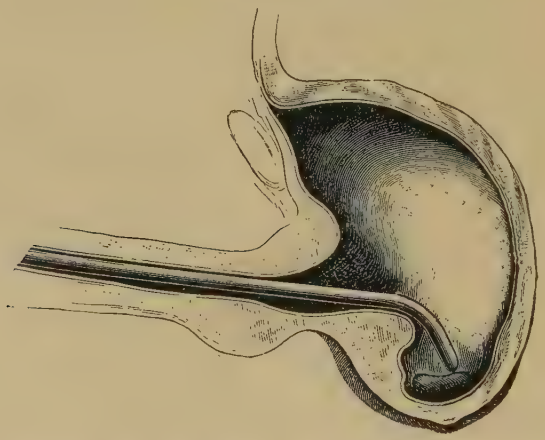
Diagnosis.—In many cases the symptoms are sufficient to establish a diagnosis of vesical calculus. In others the diagnosis must rest upon the results of physical examination, palpation, examination with the sound or cystoscope, and, finally, the *x*-ray. If the calculus is large and the patient emaciated, it may be felt suprapubically, or by combined rectal and suprapubic palpation. Such examination is of great importance in children, since it may render unnecessary the passage of instruments through the delicate urethra. In a child even a small calculus can often be felt most distinctly, while a larger one can sometimes be pressed against the anterior abdominal wall so plainly that its outline can be seen.

In a few cases the presence of a calculus may be recognized by means of an elastic catheter, but usually this knowledge is only to be gained with a metallic instrument. The technic of such an examination is described on page 421. In examining a person with hypertrophied prostate for calculus, the beak of the sound should be rotated through 180 degrees, as shown in Fig. 207.

If a calculus is detected, it should be given slight quick taps with the beak of the sound. The resulting click can be distinctly

heard even though the calculus be rather soft. If the symptoms point to a calculus and examination with the sound is negative, it is not safe to conclude that no calculus exists, as numerous instances have shown that a calculus of considerable size may escape detection

FIG. 207.



Method of examination for vesical calculi in the presence of prostatic hypertrophy.

with a sound. Figs. 208 and 209 show how this is possible. In most cases the sound will show whether an operation is necessary. If, when the sound is turned both to the right and to the left, it strikes against a calculus, the surgeon is justified in concluding that at least two are present, and in some cases he is able to affirm that the calculus is movable or fixed, as the case may be.

The size of a calculus can be estimated as follows: The surgeon, while tapping the calculus lightly, gradually pushes the sound onward until its beak no longer strikes the side of the calculus. He then grasps the instrument so that the nail of his thumb just touches the tip of the penis, and gradually withdraws the sound, tapping against the calculus until the beak of the sound no longer strikes it. The distance between the thumb-nail and tip of the penis will correspond to the diameter of the calculus.

From the character of the click produced when the sound strikes the calculus one may infer whether the calculus is soft or hard. Examination with the sound is also of value in determining the relations of the vesical cavity, and especially of the fundus.

Examination with a cystoscope is far superior to that with the sound, since it yields absolutely accurate information. A calculus can be distinctly seen, and, if necessary, photographed. The size, shape, character, and number of the calculi are easily recognized. (Figs. 210 and 211.) One can also see whether the calculus is movable, or embedded in the vesical wall. The beginner is apt to

overestimate the size of a calculus seen through a cystoscope; but this error in judgment is easily overcome by practice. Furthermore, the cystoscope gives accurate knowledge in regard to the condition of the bladder, and especially the fundus of the bladder. It is, therefore, of great value as a preliminary to lithotrity. The only cases in which examination with the sound is preferable to that with the cystoscope are those in which the hemorrhage is so profuse that the field of vision is obscured.

FIG. 208.

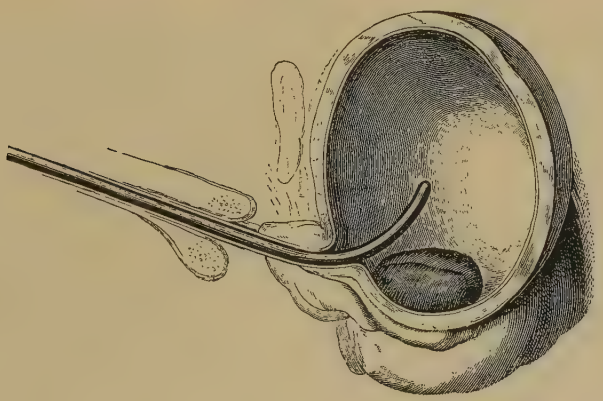
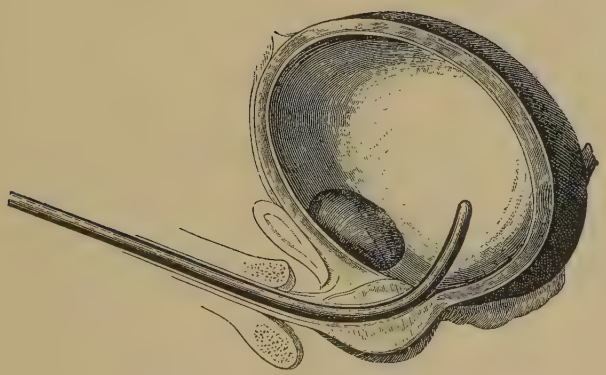


FIG. 209.



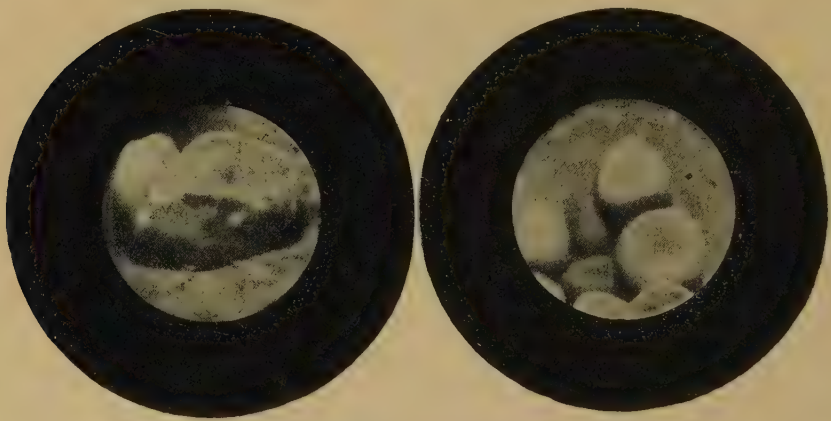
FIGS. 211, 212.—Showing how a large vesical calculi may escape detection with a sound.

Large vesical calculi formed of phosphates or calcium oxalate can be clearly shown in a radiograph. Calculi composed of urates do not sufficiently intercept the light to be shown in this manner.

Prognosis.—Small calculi may be passed by the patient with the urinary stream. Men may pass in this manner calculi measuring 12 mm. (0.5 inch) in diameter, and women have passed spontaneously calculi as large as a pigeon's egg. The tendency of a

calculus in the bladder is to grow constantly larger by the successive deposition of the same or other urinary salts. Fig. 181, p. 460, shows how rapidly a calculus may form. Usually the symptoms increase with the increase in the size of a calculus, and sooner or later cystitis develops, which may extend to the renal pelvis and set up a pyelonephritis. If left to themselves, most patients succumb to septic or uræmic complications, after having suffered for a long period.

Fig. 210. Fig. 211.



Cysto-photographs of vesical calculi.

Treatment.—All attempts to dissolve vesical calculi by medicine or vesical irrigation have failed. While a little powder from a vesical calculus is easily dissolved, a small fragment of the same calculus resists solution on account of the organic framework upon which it is constructed. A vesical calculus can therefore be removed only through an incision or after it is crushed through the urethra.

The incision of the bladder for a calculus, or lithotomy, as it is called, was practised by the ancient Egyptians and Indians. The ancient practice was to insert one or two fingers into the rectum, and to press the calculus downward against the perineum in order to cut directly upon it. This operation was performed by wandering specialists, and both in the time of Hippocrates and even in the middle ages regular surgeons were forbidden to practise it. In the sixteenth century median perineal lithotomy, and later lateral perineal lithotomy, and finally suprapubic lithotomy, were all performed by recognized surgeons.

Median Lithotomy.—Median lithotomy is essentially an incision into the membranous portion of the urethra, followed by dilatation of the prostatic urethra. This operation is extremely simple. The patient lies upon the back, with the thighs flexed and abducted; the operator sits before him, and an assistant holds a grooved sound

PLATE XVII.

Ascending Pyelonephritis and Abscess of Kidney; Enormous Vesical Calculus and Cystitis. (Taylor.)

directly in the median line, pressing it against the perineum, while with the other hand he draws the scrotum up out of the way. The operator makes an incision in the median raphe about 5 cm. (2 inches) in length exposing the bulb of the urethra and dividing the fibres which connect the bulbocavernosus muscle with the sphincter ani. The incision is deepened until the groove in the sound is felt, and the urethra is opened with a sharp knife from behind forward for a distance of 2 to 2.5 cm. (0.8 to 1 inch). The sound is withdrawn and the operator gradually works his forefinger through the prostatic urethra into the bladder. The finger is withdrawn, a pair of calculus-forceps is inserted into the bladder, and the calculus is seized and extracted. In this manner calculi measuring 3 cm. (1.2 inches) in diameter may be extracted without rupture of the prostatic urethra. If the stone is larger than this, it is better to cut forward through the neck of the bladder and the prostate gland rather than to tear seriously the prostatic urethra. A soft rubber catheter is inserted and left in position, and the wound is tamponed with iodoform gauze.

Lateral Perineal Lithotomy.—For lateral perineal lithotomy the position of the patient is the same. The assistant stands at the right side of the patient and holds the handle of the grooved sound to the right side. The incision begins near the middle of the raphe and ends in the middle of a line drawn from the anus to the left ischial tuberosity. It divides successively the skin, superficial fascia, transverse perineal vessels, and deep perineal fascia. The groove in the sound can then be felt and cut down upon. The operator then takes the sound, presses it against the symphysis without changing its direction, and pushes with it the knife below and to the left until its point reaches the bladder, thus dividing the membranous urethra and a portion of the prostate sufficiently to permit extraction of the calculus. A soft catheter is inserted and left in position, and the wound is tamponed with iodoform gauze.

Formerly perineal lithotomy was often combined with lithotrity, the crushing instrument being introduced through the perineal wound and the pieces of a large calculus extracted one after the other. The crushing of the calculus and the extraction of the sharp fragments often wounded the bladder or the urethra, so that this operation is no longer performed.

Suprapubic Cystotomy.—The bladder may be opened above the pubes under the influence of either a general or a local anæsthetic. If a local anæsthetic is employed for the incision, the bladder should also be anæsthetized by the introduction of eucaine.

The first step in the operation is the insertion of a metallic catheter into the bladder, the curve of which should correspond to the prostatic condition of the patient. When the urine has been withdrawn, the penis is ligated around the catheter by means of a slender rubber tube, air is injected into the bladder, and the end of the catheter is closed. Air is preferable to any fluid, since

the latter flows into and soils the wound as soon as the bladder is opened. The distention of the bladder should be sufficient to bring it near the anterior abdominal wall and to push upward the peritoneal reflection. Too great distention may rupture the bladder, an accident which is more likely to occur in the aged, for in them the wall of the bladder is often as thin as paper. The safest plan is to test the capacity of the bladder before the patient is anæsthetized, and afterward to distend it with air to the same degree. If necessary, the bladder can be opened suprapubically without any distention. Under such circumstances it is necessary to look out for the peritoneal reflection, and to draw it upward out of the way before extending the incision to the wall of the bladder itself. In a few cases the reflection of the peritoneum is adherent to the symphysis. It can easily be separated by a couple of transverse incisions and drawn upward without being opened. If it is opened accidentally before the bladder is cut into, the wound should at once be sutured, and when this has been done, the risk of peritonitis is scarcely worth consideration. Distention of the rectum by means of a rubber bag is a wholly superfluous procedure and one which sometimes increases hemorrhage. The rectum has more than once been injured in this way.

If the bladder is opened for the extraction of a calculus, the incision should be longitudinal, since this wound heals better than a transverse one, and is less likely to be followed by hemorrhage. The external incision begins 2 cm. (0.8 inch) above the upper margin of the symphysis and extends upward a distance of 10 or 12 cm. (4 or 4.8 inches). If additional room is necessary, the attachment of the recti muscles may be nicked. The deep fascia is divided for the same distance as the skin between the pyramidal muscles. When the edges of the wound are held apart, the loose connective and fatty tissues of the prevesical space will be exposed. These tissues are easily torn through with the forceps or the finger. Sometimes a few veins require ligation. This dissection should freely expose the bladder as far as the peritoneal reflection. The latter is the surest indication that the wall of the bladder is exposed below it. The wall of the bladder may also be known by its brownish-red color and longitudinal bands of muscle-fibres. At this stage of the operation the pelvis of the patient should be well elevated in order to facilitate extraction of the stone and the subsequent suture of the bladder.

Before the bladder is opened, it should be secured with two hooks or threads passed either transversely or longitudinally. The tip of the catheter is pressed up between them, and upon it the bladder is incised transversely as high up as is convenient. This facilitates extraction of the calculus and makes an easy suture, and avoids the large veins, which increase in size and frequency toward the neck of the bladder. A transverse incision in the bladder is more easily

and perfectly sutured than a longitudinal one. This is especially true if the suture is in two layers. There must, of course, be sufficient room between the incision and the peritoneal reflection to permit of easy suture, otherwise additional space must be gained by the dissection upward of the peritoneum.

The surgeon passes a finger into the cavity of the bladder in order to determine the probable size and position of the contained calculi. Larger calculi are extracted with special forceps. The calculus should be grasped firmly in its shortest diameter and extracted if possible without crushing. All injury to the edges of the wound in the bladder should be avoided. If the wound is not long enough to permit extraction of the calculus, it should be lengthened. Small calculi are best extracted with a scoop guided with the finger. Before closing the bladder the surgeon should, by careful palpation, convince himself that no calculi or fragments of calculi remain behind. If there are deep pockets in the base of the bladder, they cannot be reached with the finger, but should be washed out by the forcible injection of large quantities of fluid through the catheter. This fluid is allowed to flow out through the suprapubic incision, the patient being placed upon his side or partly upon his face. The effectiveness of this flushing of the bladder can be increased if the surgeon closes the wound in the bladder with the finger until the bladder is distended, and then suddenly withdraws it.

The author drains the bladder in all cases through a small perineal incision. The cut is made upon a pair of long, slender clamps introduced from the bladder into the posterior urethra. A soft rubber catheter (No. 26) is then seized with the clamps and drawn into the bladder. This is stitched in the perineal wound with silver wire, which should not perforate the lumen of the catheter. This perineal drainage avoids the disadvantages of a permanent urethral catheter, and gives the best guarantee for the constant flow of urine from the bladder and rapid union of the vesical incision. As above described, the urethral incision is quickly made and the wound heals rapidly as soon as the catheter is withdrawn.

The suprapubic incision in the bladder may or may not be sutured. If there is severe cystitis, or if the edges of the wound have been badly torn, it is better to leave it open, inserting through it two soft rubber drains as thick as the finger whose ends reach to the base of the bladder. Other surgeons use a T rubber drain, or an angular glass drain, the outer end of which is connected by means of a rubber tube with a vessel containing an antiseptic solution. The outer end of such a drain must be lower than the inner end of the incision, and the incision in the bladder should be accurately sutured without it. If the wall of the bladder is fastened to the recti muscles by a few sutures, it will be prevented from sinking too far away from the surface. The skin and deep fascia are

also sutured. Such drainage, in combination with the perineal catheter, permits free irrigation of the bladder and the most thorough treatment of existing catarrh. If there is no catarrh, the incision in the bladder should be carefully sutured. Such wounds almost invariably unite in a few days, and even if a few stitches give way, the permanent union is hastened by suture.

Catgut is the suture material most used, though some surgeons prefer silk or silver wire. The suture should be so placed that the external surfaces of the bladder are in apposition, and the cut edges of the incision are turned inward. The stitches should be so inserted as not to penetrate the lumen of the bladder lest they become incrusted with urinary salts. A second row of stitches applied over the first approximates the vesical wall throughout the proper area and thus gives greater certainty of union. Small openings in the bladder can be closed by a purse-string suture.

Some surgeons tampon the external wound for a few days in order to see whether the wound in the bladder remains closed. Others suture also the deep fascia and skin, with or without a small drain in the lower angle of the abdominal wound. If the incision in the bladder is sutured, one must provide for the escape of urine, either by perineal drainage as above described, or by a catheter left in the urethra, or by catheterization of the patient every two hours. It is risky to trust to voluntary micturition unless the wound in the bladder is extremely small. If a catheter is left in the urethra, the surgeon should see to it by repeated examination that the catheter acts satisfactorily; and if it shows any tendency to become incrusted, it should be at once removed and another inserted.

Lithotomy in Women.—The female urethra is so distensible that large calculi may be extracted through it if the external meatus is nicked in one or two places.

The bladder is easily opened through the vagina. A sound is passed into the bladder, and the vesical vaginal septum is incised longitudinally upon it. Additional space may be obtained by a transverse incision. Such wounds should be accurately sutured and usually heal by primary union. The operation is an easy one if the vagina is wide, and is still more simple when a cystocele coexists.

Lithotrity.—The crushing of a stone within the bladder and the removal of its fragments in one or many sittings are an operation of recent date, first practised by Gruithausen and Civiale. In America it is associated with the name of Bigelow, who first insisted on the importance of breaking up and removing the whole of a calculus at one sitting no matter how large the stone might be. He showed that the bladder suffers less from prolonged instrumental manipulation of this sort than it does from the subsequent presence of sharp fragments of calculus. He made use also of an evacuator to facilitate removal of the fragments, thereby protecting the urethra from injury due to the sharp angles of a broken calculus.

Bigelow made use of instruments of very large calibre, but this is unnecessary, since those having a calibre of No. 25 are sufficiently large for practical purposes.

The jaws of a lithotrite are variously constructed according to the force required, and the size of the calculus or the fragments which it is desired to break up. (Figs. 212, 213, and 214.)

Fig. 212.

Fig. 213.

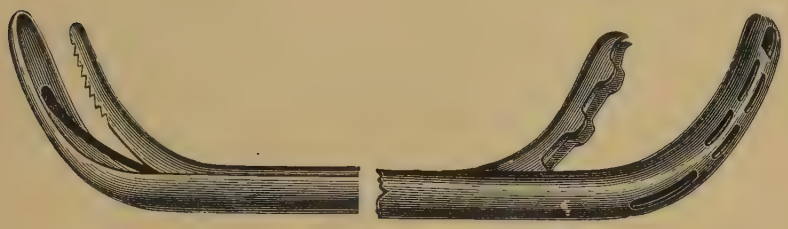
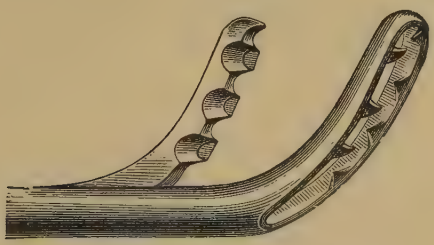


Fig. 214.



Different types of lithotrite.

The handle of a lithotrite is so constructed that when a calculus is grasped in the jaws it is firmly fixed, and rotation of the handle serves to crush it. Before the jaws are set upon a calculus they can be moved freely backward and forward in their search for a calculus. These two motions are variously secured in different instruments. (Figs. 215, 216, 217, and 218.)

The evacuation pump consists of a powerful rubber aspirator, a small glass bulb to collect the fragments of calculus, and a catheter of large calibre. (Fig. 219.)

In crushing and removing calculi from the bladder it is important to avoid infection of this organ. The lithotrite, catheter, etc., should be boiled, or otherwise sterilized. The evacuation pump cannot be boiled. It must be disinfected as nearly as possible by means of solutions of nitrate of silver or other antiseptic substances.

The patient lies upon the back with the pelvis elevated. The glans and body of the penis, the scrotum, pubic region, and thighs are freed from hair and thoroughly cleansed. The urethra is irrigated with a sterile boric acid solution. If cystitis is present, the bladder

is also irrigated unless hemorrhage or contraction is produced thereby. If the calculus is small and the patient is not very sensitive, a local anæsthetic will suffice. The best for this purpose is a 2 per cent. solution of eucaine employed in the urethra and bladder. Cocaine is dangerous. If the calculus is large or the patient nervous, or if the prostate gland is hypertrophied, or there are other complicating symptoms, a general anæsthetic is indicated, preferably morphine and chloroform. The reflex action of the bladder is not suspended until the patient is fully anæsthetized. A calculus should not be crushed when the bladder is empty lest the fragments injure the mucous lining. Too much fluid is a disadvantage on account of the distance through which the fragments of calculus may escape. The bladder should contain from 100 to 120 c.c. (3 to 4 ounces).

FIG. 215.

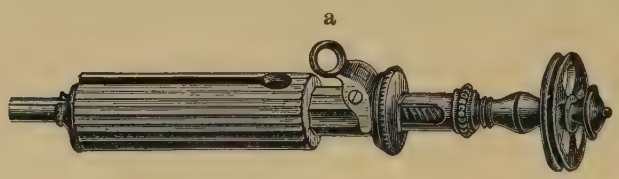
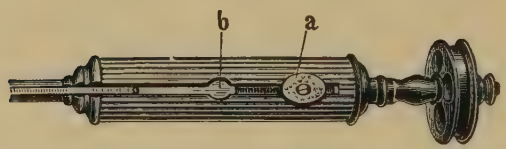


FIG. 216.

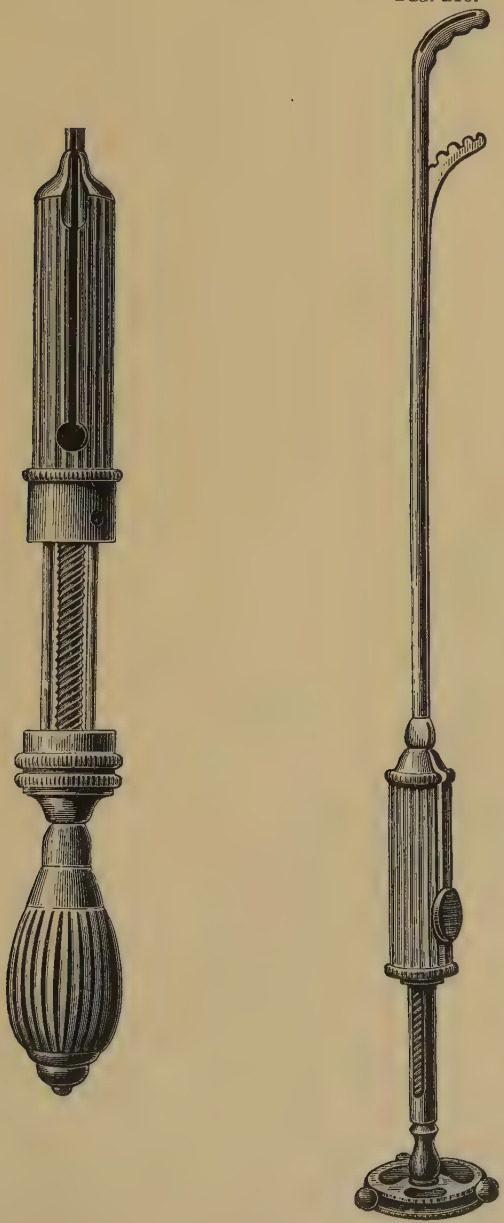


Various types of lithotrite, showing the difference in the mechanism in the handle: *a*, the catch which releases or holds the screw so that the jaws are either lightly separated or firmly screwed together; *b*, the point to which the sliding catch, *a*, moves.

The lithotrite is inserted into the bladder and so held that the shaft lies on the base of the bladder with the beak directed forward. The male blade is then withdrawn until it touches the internal urethral orifice, and again passed inward until it touches the female blade or seizes the calculus. If the base of the bladder is flat, or nearly so, the calculus may be caught at the first attempt and crushed. If there is more or less of a recess, it may be necessary to turn the instrument a little to one side, and again to open and shut its jaws in order to seize the calculus. When the calculus has been broken, its pieces are sought in like manner, and again broken until small enough to wash out through the catheter. One familiar with the instrument can break up ten or twelve pieces in a minute. If the calculus is situated in a deep recess in the base of the bladder, it may be necessary to reverse the instrument in order to seize it. When seized, it is lifted forward by careful rotation of the instrument, and then crushed. A similar procedure is necessary in order

Fig. 217.

Fig. 218.



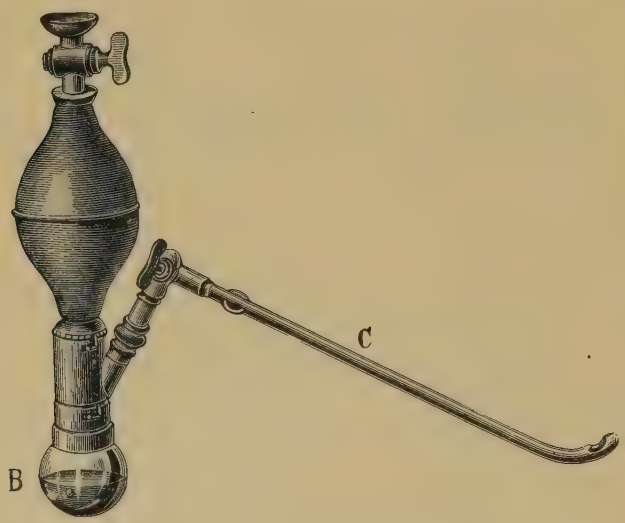
Various types of lithotrite showing the difference in the mechanism of the handle.

to seize and crush every fragment, and only by the greatest care is laceration of the mucous membrane to be avoided. If the conditions of the vesical wall and the position of the calculus have been

first determined by the use of the cystoscope, the search for and crushing of the calculus are greatly facilitated.

When the calculus has been thoroughly broken up, the lithotrite is removed and the evacuation catheter (Fig. 221), or, still better, the cystoscopic evacuation catheter (Fig. 220) is introduced. Fluid is injected into the bladder with considerable force and the small particles of calculus are washed out and collected in the glass. When the water returns clear and no click of fragments is heard against the end of the instrument, it is fair to assume that no fragments are left. If the cystoscopic catheter is employed, one can inject 150 c.c. of clear boric acid solution, and by turning on the light actually see whether or not any fragments remain behind. If such are seen, or

Fig. 219.

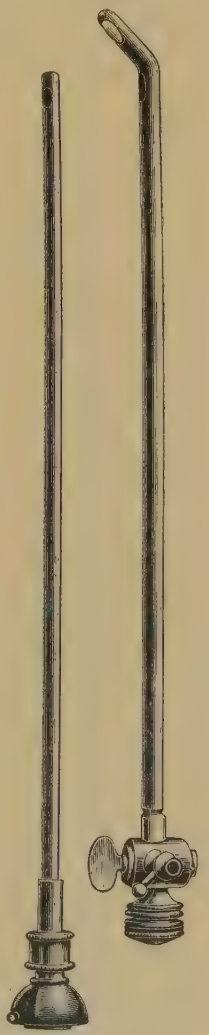


Evacuation pump for use in lithotrity.

if their presence has been shown by repeated clicks against the catheter, the catheter must be withdrawn, the lithotrite again inserted, the fragments caught and broken, the lithotrite removed, the catheter inserted, and the remaining detritus washed out. It is desirable to break up the calculus thoroughly at first in order to avoid reintroduction of instruments. Still, it is absolutely necessary not to leave any fragments in the bladder. Before withdrawing the catheter for the last time the bladder is quickly irrigated with 100 c.c. (3 ounces) of a 1 : 500 nitrate of silver solution. This is allowed to escape, and 100 c.c. (3 ounces) of boric acid solution are injected and left in place. This nitrate of silver solution is a good preventive of catarrh, which may follow the accidental introduction of micro-organisms.

If the patient's bladder is sound, no further treatment is necessary. If he suffers from marked prostatic hypertrophy, or severe cystitis, or if the operation has been accompanied by a good deal of hemorrhage, it is better to leave a soft catheter in the bladder for some days. If cystitis which preëxisted, persists, or if, as rarely happens, the operation sets up a cystitis, the patient should be treated by boric acid irrigation or irrigations of weak solutions of silver nitrate.

FIG. 220.



Cystoscopic evacuation catheter.

In comparing the different operations for vesical calculus, one may safely reject lateral lithotomy on account of its risk and the possibility of injuring the ejaculatory duct.

Median lithotomy is easily performed, and the period of recovery occupies only two weeks. It is not adapted to the removal of very large or incrusted calculi, and is not to be recommended if the prostate is much hypertrophied. Suprapubic cystotomy is a simple operation, accompanied by only a slight loss of blood. Recovery may be complete in three weeks, but is sometimes delayed, and in a few cases a fistula persists. The risk of urinary infiltration, suppuration, and pyæmia is practically *nil* when the operation is properly performed. The mortality depends upon the general condition of the patient, being very slight among healthy individuals, but considerably greater—20 per cent. or more—in aged persons with renal affections or other complications.

Lithotrity demands an especial facility with special instruments. In simple cases the technic is easy. If the calculus is large, or lies in a narrow depression, and if there is a high degree of prostatic hypertrophy, the skill of the operator may be taxed to the utmost. The beginner will do well to confine his attempts to smaller calculi which are easily accessible, removing others through a suprapubic incision. As his skill in lithotrity increases the operator will limit more and more the field of cystotomy.

The results of modern lithotrity are excellent. The risk of leaving fragments of a calculus in the bladder is readily avoided by the use of the cystoscope. In uncomplicated cases the patient can leave his bed on the following day. The risk of the operation depends not a little upon the skill of the operator. Injury of the bladder may produce hemorrhage, peritonitis, or septic and uræmic

symptoms which may cause the death of the patient in a short time. The author has performed lithotrity 348 times, with 7 deaths, a mortality of 2 per cent.; 2 of the patients died of pneumonia eight

Fig. 221.

Otis evacuator.

and seventeen days after operation, 1 of embolism following phlebitis, and 1 of a burn of the thigh seventeen days after the operation. Other authors have given the mortality at figures varying from 3 to 5 per cent.

Stricture of the urethra is no counterindication for lithotrity, provided it can be sufficiently dilated to permit the passage of the necessary instruments; nor is slight cystitis a counterindication. If the cystitis is severe, and especially if of a purulent, hemorrhagic, or gangrenous character, or if the prostate is so hypertrophied that instruments are introduced with difficulty, or if their introduction causes severe hemorrhage, or if there is advanced disease of the kidneys, cystotomy is preferable to lithotrity. It can be performed under a local anæsthetic, and the patient thereby avoids the risk of protracted narcosis.

Lithotrity is the operation of choice for large calculi in women. Smaller calculi can be removed intact through the dilated urethra.

Suprapubic cystotomy should be chosen for the removal of a vesical calculus in a boy under fourteen years of age.

Recurrence of a vesical calculus undoubtedly takes place in many cases in which the previous calculus was entirely removed. Phosphates are easily deposited in the presence of the alkaline degeneration which is so common as the result of prostatic hypertrophy. The cure of the cystitis in such cases is the best means of preventing the formation of new calculi. If the formation of new calculi cannot be prevented, such as do form should be pumped out of the bladder through the evacuation catheter every three or six months, while they are still so small that this can readily be accomplished.

TUMORS OF THE BLADDER.

Pathological Anatomy.—Accurate knowledge of tumors of the bladder during life has been possible only since the development of the cystoscope. With the aid of this instrument antiseptic surgery has been able to achieve much in their treatment.

Tumors of the bladder may be primary or secondary—that is, extending from neighboring organs, or metastatic. Tumors of the third class are extremely rare. Secondary tumors in women come from tumors of the uterus and vagina; in men, from tumors of the prostate; and in both sexes from tumors of the urethra and intestine. For the most part they are carcinomata. Tumors of the prostate extending secondarily to the bladder give the same symptoms as those of the bladder itself; and even at autopsy it is often impossible to say in which organ the tumor began. Benign tumors of the prostate reaching into the bladder are rare. They are called fibroadenomata or myomata, according to the predominance of cellular or muscular tissue. Both are broad, sessile or pedicled tumors, covered with normal mucous membrane and situated near the neck of the bladder.

Tumors springing from the wall of the bladder are divided by Küster into: 1, those which originate from the mucous membrane

or submucous connective tissue; 2, those which spring from the epithelium of the bladder or of its scanty glands; and, 3, those which spring from the muscular layers of the bladder.

The commonest and most important tumor of the mucosa and submucosa is the papilloma, or papillary fibroma, as it is called by Virchow. (Fig. 222.) Such a tumor consists of a branching connective-tissue centre with a fine network of vessels every portion of which is covered by a thinner or thicker epithelial layer. Such a tumor may therefore present the appearance of a cauliflower, or the branching papillæ may terminate in long threads which float in fluid

Fig. 222.

Multiple villous papillomata of the bladder.

like fine seaweed. (Fig. 223.) Sometimes a papilloma presents somewhat the appearance of a cock's comb. Most benign papillomata have a distinct pedicle, which is plainly to be seen when one lifts the sides of the tumor from the wall of the bladder. In other cases a great number of small papillomata like moss are attached close together to the mucous membrane of the bladder.

In addition to these branching papillomata there are the usual fibromata of the bladder, tumors made up of firm connective tissue and covered by normal or thickened mucous membrane.

Myxomata are half-transparent tumors which project into the lumen of the bladder and occur chiefly in young children. They

PLATE XVIII.

Villous Tumors of Bladder. (Taylor.)

may protrude from the urethra if the patient is a girl. They form the connecting link between the benign tumors and the rare sarcomata, either round-celled or spindle-celled.

FIG. 223.

Solitary papilloma of the bladder. (Thompson.)

The epithelial tumors of the bladder are adenoma and carcinoma. Adenoma may occur in any portion of the bladder, even in the vertex, where there are normally no glands. Such a tumor is made

FIG. 224.

Section of adenoma of the bladder. The tumor was as large as an apple, and situated at the vertex.

up of branching tubules lined with a single layer of cylindrical epithelium. (Fig. 224.) It may be flat or nodular, but is rarely polypoid.

Carcinoma of the bladder shows a strong tendency to the formation of papillæ. Such papillæ are scarcely to be distinguished from those of a benign papilloma, but the base of a papillary cancer shows the characteristic infiltration.

The next most common type of cancer of the bladder is the medullary. Such a tumor forms soft broad nodules which grow rapidly and may involve almost the whole of the vesical wall.

Scirrhous carcinoma is less common, and the gelatinous form of the disease is very rare.

In a few instances cysts of the bladder have been observed to develop from the scanty glands situated in the base of the organ. Thompson mentions true dermoid cyst of the bladder. Most of the cases in which hair has been passed with the urine were those of dermoid cyst of the ovary which had ruptured into the bladder.

Myoma is another rare form of tumor which springs from the muscular layer of the wall of the bladder. Such a tumor is usually pedicled, and may develop within the organ, or it may grow outward into the peritoneal cavity.

Most tumors of the bladder are situated in the base of the organ in the vicinity of the ureteral orifices, or near the orifice of the urethra. Carcinoma, with the exception of the papillary form, adenoma, sarcoma, and myoma usually remain solitary, no matter how extensive their growth, while myxoma and papilloma whether benign or malignant, tend to become multiple, so that the whole lining of the bladder may become studded with larger or smaller tumors. The later tumors of the group are apparently due to direct contact of the healthy mucous membrane with the pre-existing tumors. In several instances in which a benign papilloma has been removed by suprapubic cystotomy many new tumors have developed on the scar within a few weeks, as shown by cystoscopic examination. Such new tumors seem to be the result of inoculation of the wound with the old tumor at the time of operation.

Tumors of the bladder are, in general, rare. Küster found that they formed only 0.25 per cent. of nearly twenty thousand cases of tumor observed in the Augusta Hospital. Gurlt mentions their frequency as 0.39 per cent. Since the introduction of the cystoscope the number of tumors observed during life has greatly increased. The writer has records of 304 examined by himself, 272 of which occurred in men and only 32 in women. Secondary tumors are more frequent in women than in men, on account of the frequency with which carcinoma occurs in the female genital organs.

Myxoma is rarely seen in persons over six years of age. Carcinoma is a disease of advanced age. Benign papilloma may occur at any time after puberty. Writers are not at all agreed as to the relative frequency of benign and malignant tumors of the bladder. Most benign tumors are papillomata, while most malignant tumors are carcinomata, and, as above stated, the papillary form is most

PLATE XIX.

Carcinoma of Bladder and Rectum. (Taylor.)

often seen. Küster has shown that in the base of a benign papilloma there are nests of cells which can easily be mistaken for the cells of carcinoma. Furthermore, an inflammatory infiltration of small round cells in the base of one of these tumors has sometimes been mistaken for carcinomatous degeneration. In the author's collection of cases of tumors of the bladder careful microscopical examination was made 222 times; 151 such tumors were benign and 71 malignant. Papilloma occurred 144 times, carcinoma 64 times, sarcoma 7 times, myxoma 5 times, and adenoma 2 times.

The question of practical importance is, of course, the possible change of a benign tumor into a malignant one. Winkel mentions a case of such transformation. The writer has never known a case in which the structure of the tumor was found to be different when examined at different periods of development.

A tumor of the bladder may undergo changes in the course of time. There may be hemorrhage into the epithelium which leads to necrosis and casting off of portions of the tumor; or deep and wide ulcers may form in the carcinoma, which in rare cases perforate the vesical wall and establish communication with the intestine. If cystitis develops, the tumor is affected as well as other portions of the wall of the bladder. It swells and becomes partially gangrenous. In severe cases earthy salts are deposited which may incrust the surface of the tumor. The ureters and pelves of the kidney are often dilated as a result of obstruction at their termination in the bladder.

Etiology.—Little is known as to the origin of tumors of the bladder. Neither gonorrhœa nor cystitis is capable of producing a papilloma. They can at most produce only a circumscribed villous degeneration of the mucosa. If repeated irritation of the vesical wall could produce a tumor, they ought to be found in connection with vesical calculi, which is not the case. Fehr called attention to the relative frequency of tumors of the bladder among workers in aniline dyes.

Symptoms.—A benign tumor of the bladder may for a long time produce no symptoms other than intermittent attacks of hæmaturia. Such attacks occur without apparent cause, are not influenced by medication, and spontaneously disappear. It is different with the hæmaturia which accompanies a calculus, for this is increased by bodily motion and subsides under the influence of rest. Rest and motion have no effect upon the hæmaturia due to a tumor. Sometimes this hæmaturia disappears after a single micturition. At other times it lasts for weeks. Sometimes all the urine which is passed is bloody; sometimes it is clear until the last few drops. Sometimes the hemorrhage is insignificant, sometimes it is very profuse, although death from hemorrhage due to this cause is extremely rare. The frequency and amount of hemorrhage increase with the increase in size of the tumor.

As long as the blood is fluid or forms only small clots, it gives rise to no symptoms. If large clots are formed in the bladder, their passage may cause the patient great pain, or they may prevent the passage of urine.

Hemorrhage is the first symptom of benign tumor of the bladder except in the few cases in which a small-pedicled tumor, acting as a valve, obstructs the internal urethral orifice. In many cases of papilloma the fragments of the tumor become detached and passed with the urine. This occurs occasionally, but there are often instances in which tumor fragments have been passed at almost every micturition for periods of weeks or months. Spontaneous cure has been known to result in this manner in the case of a small-pedicled tumor. Usually, however, new papillæ grow from the base of an apparent pedicle, so that the absence of hemorrhage for a considerable period must not be accepted as a proof of cure. The only reliable evidence is that obtained by the cystoscope.

The loss of blood from the bladder is looked upon by some patients as a favorable symptom, as is the loss of blood from hemorrhoids. They express themselves as feeling better after an attack of hæmaturia is over. In general, however, the hemorrhage increases in frequency and amount as time goes on, and the patient begins to show the symptoms of repeated loss of blood in his pale, waxy color and tendency to palpitation and faintness. When the tumor begins to interfere with the passage of urine, the patient suffers extremely. Secondary changes are set up in the beginning, and sooner or later most patients succumb with uræmic symptoms. In this way death is the direct result of a benign tumor of the bladder after, it is true, a considerable lapse of time. There are patients who suffer from occasional hemorrhage for twenty years. There are few cases, however, which run so long a course without complications. Usually cystitis develops and aggravates the symptoms and hastens the course of the disease. Such a cystitis is generally the result of the passage of instruments for diagnostic or therapeutic purposes.

After cystitis develops, the urine is no longer clear between the attacks of hæmaturia, and the patient is no longer absolutely free from symptoms. He suffers more or less from vesical tenesmus, and before a great while the inflammation is likely to ascend to the kidney, giving rise to pyelitis or pyelonephritis. The patient, already weakened by loss of blood, by pain and sleeplessness, will then succumb to septic uræmic symptoms.

A malignant tumor of the bladder produces after a time symptoms which are scarcely to be distinguished from those of a benign tumor. Hemorrhage may be the only symptom noticed. In every case there is more or less pain and tenesmus even though the urine is aseptic. This is a result, doubtless, of infiltration of the wall of the bladder, which is wholly wanting in connection with a benign tumor.

Bodily motion may also cause the patient pain, so that the symptoms may resemble those of vesical calculus. The course of the disease is in general a rapid one; still there are numerous instances in which a patient has lived for some years. In such cases the question may fairly be raised whether the tumor was from the first malignant, or whether it became so in its later development.

As long as cystitis is absent the symptoms of carcinoma of the bladder are not insufferable. The patient rarely shows the cachexia which is so often seen in connection with carcinoma of other organs. In general, however, cystitis is an early complication, and the accompanying changes in the urine are more marked than are those due to cystitis in connection with benign tumor. The urine takes on a purulogangrenous character, and has a foul odor which of itself is almost characteristic of carcinoma of the bladder. Such a patient is likely in a short time to develop pyelonephritis and to die with septic uræmic symptoms.

The course of adenoma of the bladder is similar to that of carcinoma, while that of sarcoma is marked rather by difficulty in the passage of urine.

Children with myxoma do not suffer from hæmaturia, but from tenesmus and pain on micturition. Cysts and myomata, as far as they produce symptoms, interfere more or less with the function of the bladder. Whether they do so or not depends upon the position of the tumor, its shape, etc. Even in these cases, cystitis, and, later, pyelonephritis, are complications which usually occur sooner or later.

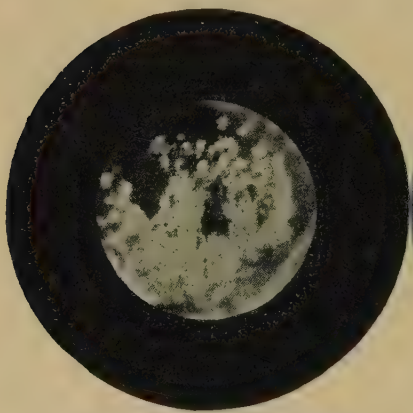
Diagnosis.—In the early stages of tumor of the bladder the symptoms are often so clear that a diagnosis is easily made. After cystitis develops, the symptoms are less characteristic and can easily be mistaken for those due to calculus, tuberculosis, etc. In such cases the patient's account of his earliest symptoms is most important. For example, if he gives a distinct history of attacks of hæmaturia without other symptoms, and which are separated by intervals in which the urine is perfectly clear, the diagnosis of tumor is probable. Such attacks of uncomplicated hæmaturia may have been due to vesical varices, or to a renal aneurism; or they may have been attacks of a so-called essential renal hemorrhage. All of these things are, however, extremely rare.

First in importance is the examination of the urine. If one finds a well-preserved fragment of a papilloma, the diagnosis is established. Usually, however, any fragment of tissue that is present is gangrenous, so that its structure cannot be clearly made out. Such a fragment of tissue often contains crystals of hæmatoidin; but these also exist in cases of severe cystitis. The urine frequently contains large quantities of polymorphous epithelial cells with large nuclei. These cells have been named cancer-cells; but too much emphasis must not be placed upon them, since the deeper layers of the normal epithelium of the bladder contain polymorphous cells. The odor of

the urine from a bladder which contains a malignant tumor is not easily described nor easily forgotten.

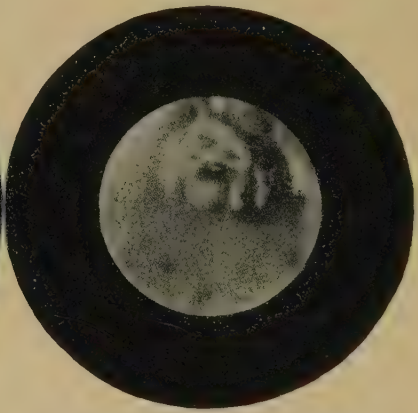
The history of the patient, his present condition, and the examination of the urine, suffice in many cases to establish a diagnosis of tumor of the urinary passages with considerable certainty. The exact situation of the tumor cannot be stated, however, except in those cases in which the tumor interferes with micturition, and in those in which there is pain in the bladder. Even then, additional information is needed to make the diagnosis a certainty. Sometimes a large hard tumor of the vertex can be felt above the symphysis.

FIG. 225.



Cysto-photograph of a carcinoma of the bladder.

FIG. 226.



Cysto-photograph of a benign papilloma of the bladder.

Combined abdominal and rectal palpation when the patient is anæsthetized yields still further information. But soft tumors cannot be felt at all, or, at most, they give the surgeon the sensation that the bladder is thicker than normal. In children these are the only means of examination which we possess.

The introduction of a sound is counterindicated in the case of suspected tumor of the bladder. It is rarely possible to feel the tumor with it, and the passage of instruments into a bladder which contains a tumor generally sets up cystitis no matter how carefully aseptic rules are followed.

By means of a cystoscope one can recognize not only the presence of a tumor of the bladder, but can also determine the situation and characteristics of such a tumor with great exactness in early uncomplicated cases. (Figs. 225 and 226.) By means of this instrument one can often say whether the tumor is benign or malignant with as great certainty as one can say this of tumors of the larynx or cervix uteri.

If cystitis is present, the conditions are not so favorable for cystoscopy. The cloudiness of the urine can be overcome by irriga-

tion, but the appearance of the tumor is modified by cystitis, so that a papilloma, instead of floating like seaweed in the fluid, is covered with necrotic tissues and thick mucus, while a carcinoma presents an appearance not unlike the folds of the inflamed mucous membrane.

Although these tumors so often give rise to spontaneous hemorrhage, they rarely bleed as a result of cystoscopic examination. If the patient is suffering from an attack of hæmaturia, it is well to wait until the urine again becomes clear. Still, a moderate amount of hemorrhage may be overcome by irrigation. There are, however, cases in which constant irrigation fails to keep the bladder clear, and others in which introduction of the cystoscope gives rise to profuse hemorrhage.

One who is familiar with the use of the cystoscope can usually determine the presence of a benign tumor, its situation, size, shape, and the number of its bloodvessels, etc. Whether the base of a tumor is infiltrated can only be shown through the cystoscope in so far as such infiltration has affected the appearance of the mucous membrane. This lack of exact information is supplemented by combined abdominal and rectal palpation. He who practises this method for the first time will often be surprised to find how plainly he can feel an extensive infiltration of the vesical wall in the case of a tumor which through the cystoscope is seen to have only a small base.

Digital exploration of the bladder through a perineal opening in the urethra, or through a dilated female urethra, is only warranted in those cases in which cystoscopy and combined rectal and abdominal palpation have failed to establish a diagnosis.

Suprapubic cystotomy is hardly justified merely as an exploratory operation. There are instances in which it is necessary to control hemorrhage. Occasionally it is desirable to cut down above the bladder to the pubis and to reflect from it the peritoneum in order to determine the extent of a tumor of the bladder, the removal of which is under consideration.

Treatment.—The hemorrhage caused by a tumor of the bladder often requires energetic treatment. There is no known method of preventing such hemorrhage, and in treating it it is better to refrain from energetic measures, and rather to keep the patient quiet, to inject ergotin subcutaneously, or administer by mouth such remedies as are in vogue for the control of hemorrhage. In general, such drugs and the recently recommended gelatin are without appreciable effect upon the hemorrhage. Above all, the surgeon should avoid the introduction of instruments and injections into the bladder, since hemorrhage is not infrequently increased thereby and a lasting catarrh is apt to follow. The rule should be not to pass instruments if the patient is able to empty his bladder spontaneously, even though the urine is deeply stained with blood. The quantity of blood which is lost is usually overestimated.

Hemorrhage, if free, may form large blood-clots in the bladder. Such a coagulation cannot be prevented, but it can be limited by giving the patient large quantities of fluids by mouth in order to increase the amount of urine. Vesical tenesmus, not due to over-distention of the bladder, may be controlled by morphine. If the clots formed cannot be passed spontaneously, it is necessary to wash them out through as large an elastic catheter as the urethra will admit. The aim should be to keep the tip of the catheter near the vertex of the bladder so that its opening shall lie in the fluid urine above the heavier blood-clots. If a clot becomes wedged in the eye of the catheter it may be driven out by a sudden injection of boric acid solution. Only in rare cases is it justifiable to break up the clots with a metal catheter or a lithotrite, and to withdraw them through an evacuation catheter. Finally, if life is threatened by the hemorrhage, the bladder should be opened suprapubically, the clots removed, and the bladder tamponed with iodoform gauze. In this manner the most severe hemorrhage can be stopped almost immediately.

One of the chief duties of the surgeon who has charge of a patient with bladder trouble is to prevent the development of catarrh, and to control it, if present. To a certain extent this may be done by the use of urotropin and similar remedies. If a severe cystitis is present, the bladder may be irrigated with disinfectants and dilute astringents.

Complete removal of a tumor cannot be effected by drugs or irrigations, but only by an operation. There are three methods employed at present: first, that of Thompson, who opened the urethra through the perineum and dilated the posterior urethra (dilatation of the urethra in women); second, the removal of tumors through the normal urethra by means of the cystoscope, a method perfected by the author; and, third, removal of the tumor suprapubically, with or without removal of a portion of the wall of the bladder. A still more radical procedure than any of these three is removal of the whole bladder with the tumor.

The technic of Thompson's operation is described on page 426. The tumor, when found, may be torn away with the finger, or by means of forceps or other instruments introduced through the perineal opening.

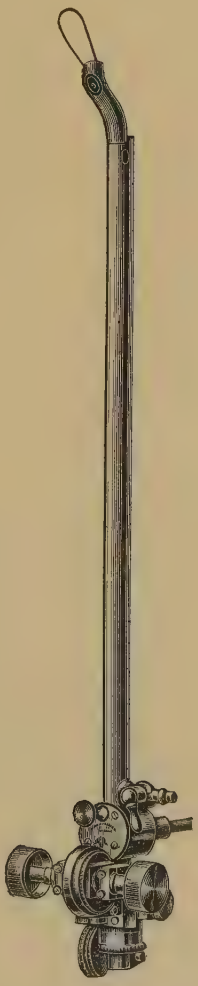
Civiale was the first to remove vesical tumors through the uninjured male urethra. This operation, as perfected to-day, is performed under the guidance of the eye, through the help of the cystoscope. The galvanocautery is employed to cut off the tumor and to cauterize its base. The cystoscope employed for this purpose is a long, slender instrument enclosed in a metallic sheath which can be slipped back and forth. (Figs. 227 and 228.) At the extremity of the sheath are found the arrangements to hold the wire loops and galvanocauteries with which to treat the tumor, while at the outer end of the sheath is an apparatus to control the wire loops and to

heat the galvanocautery. When the sheath is pushed forward to the lamp of the cystoscope it forms a solid instrument which is readily introduced into the bladder. When the instrument is in the bladder, the sheath is withdrawn sufficiently to permit inspection of

FIG. 227.

Nitze's operating cystoscope, the sheath being pushed forward.

FIG. 228.

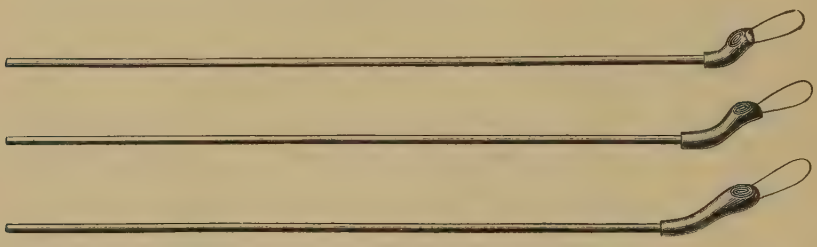


Nitze's operating cystoscope, the sheath withdrawn and the galvanic loop inserted.

the bladder through the lens of the cystoscope. A platinum loop is inserted, passed over the tumor under the guidance of the eye, and gradually withdrawn while heated by the galvanic current. (Fig. 229.)

The cauterization goes on in the bladder containing boric acid solution practically as it would if it contained air. Either the whole tumor may be thus cut away, or a portion of it, according to circumstances.

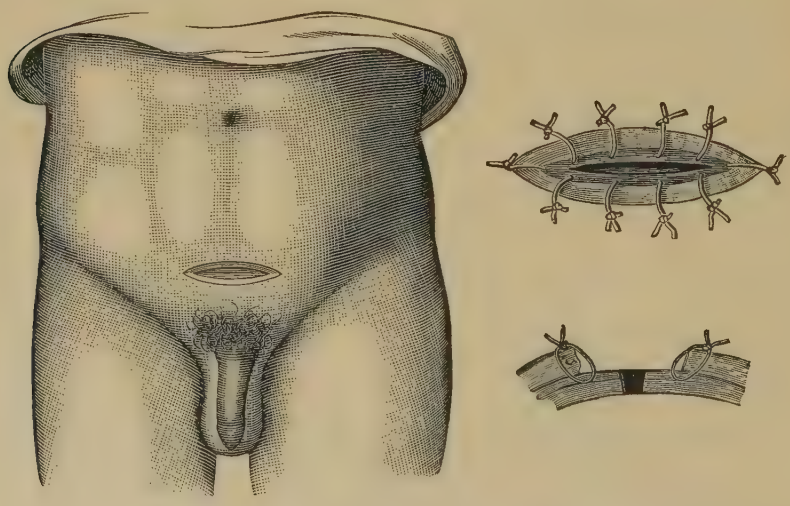
Fig. 229.



Varieties of loop employed in Nitze's operating cystosope.

The sheath is passed forward on the cystoscope and the whole instrument is withdrawn. The separated piece of tumor is usually passed with the urine. A few days later this operation is repeated, and the treatment is continued until the whole tumor has been removed and its base thoroughly cauterized. The patient is then completely cured.

Fig. 230.

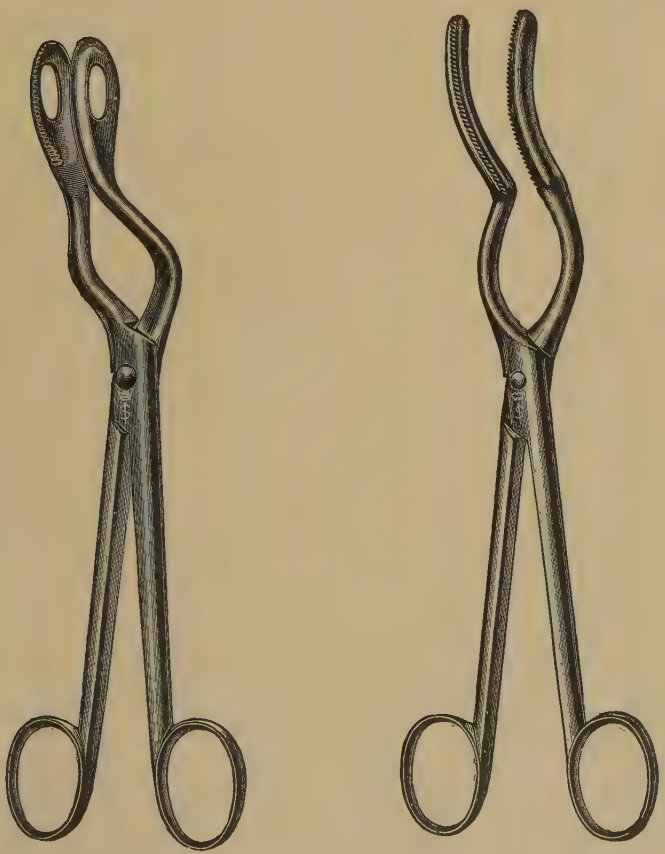


Bardenheuer's transverse incision for suprapubic section, showing manner of suturing the edges of the bladder-wound to the abdominal wall. (Guterbock.)

If one opens the bladder above the pubes for the removal of a tumor, it is well to make the incision through the abdominal wall transversely in order to gain additional freedom of inspection and manipulation. If the person is over-stout, or the tumor is very

large, or the wall of the bladder is to be in part resected, a long incision is necessary. Care should be taken not to injure the conjoined tendon. If the case is very difficult, and still more room is desired, it can be gained by drawing the skin upward and making an upward longitudinal incision in the linea alba for a distance of 2 or 3 cm. (0.8 or 1.2 inches). The bladder is then filled with air,

FIG. 231.



Two forms of Thompson's forceps for removing vesical growths.

the peritoneum reflected upward, and a transverse incision made in the bladder, and the cut edges of the bladder stitched to the skin. When this has been done and the patient placed in the Trendelenberg position the tumor is plainly visible through the gaping wound. It should be carefully palpated in order to determine its relation to the wall of the bladder. If there is a pedicle, the tumor should be lifted between the partially opened fore and middle fingers of the hand until a clamp can be placed upon the pedicle beneath

the fingers. By slow traction it is possible to bring a tumor even of the base of the bladder well into the external wound. If the tumor obstructs the view of the urethral orifices, its papillary masses should be torn away with the finger one after the other until the field of operation is exposed. Two long loops of silver wire are then placed around that part of the wall of the bladder which is elevated by the pull on the tumor and the pedicle is incised between these wire loops and the clamp; or, what is better, divided by the Paquelin cautery. Injury of the urethral orifices can usually be avoided in case of a benign growth. Still, injury or excision of such an urethral orifice is not usually followed by serious symptoms.

Fig. 232.

Nitze's bladder forceps with electric lamp for intravesical operations after suprapubic cystotomy.

The wire loops prevent the field of operation from sinking, and they also serve to control hemorrhage during the suture of the vesical wound. This should be sutured with catgut since these threads are soon softened and passed through the urine, and rarely give rise to the formation of calculi. When the suture is completed the silver wire is removed.

If the pedicle of the tumor is very slender, it may be cut off and its base touched with a Paquelin cautery. There are several instruments for the removal of benign papilloma with a broad base. (Fig. 231.) The author has constructed a special forceps in the jaws of which there are electric lights so that no portions of the tumor may be overlooked. (Fig. 232.) The base of every tumor should be thoroughly cauterized with the Paquelin cautery. If the tumor to be removed is malignant and infiltrates the wall of the bladder, the method of operating above described will not be sufficient, and will be certain to be followed by recurrence in a short time. It is necessary to remove the whole thickness of a carcinomatous, infiltrated wall of the bladder for a certain distance from the tumor.

The resection of a small portion of the bladder presents no especial difficulty, provided the portion removed is not the base of the

bladder, and does not involve the ureteral orifices. The operation is especially easy if it can be performed extraperitoneally, and it may always be performed extraperitoneally if it has not infected the peritoneum; for otherwise the peritoneum can be pulled away from the bladder. When this has been accomplished, the bladder should be opened near the tumor and the incision continued with the scissors entirely around the tumor. The incision should pass everywhere wide of the malignant growth.

If the tumor has involved the peritoneum, the original cavity should be opened and a portion of the peritoneum resected with the adjacent wall of the bladder. Great care should be taken not to allow the urine to enter the peritoneal cavity since in most of these cases it contains pathogenic organisms. In some instances it is better to open first the peritoneal cavity, to cut around the affected portion of peritoneum, and to close the wound in the peritoneum with suture before opening the bladder. The author has thus operated in case of a man aged sixty shown by cystoscopic examination to possess a malignant tumor of the vertex of the bladder.

If the tumor is large, or is situated in the base of the bladder, or involves one or both ureters, the difficulties of operation are far greater. The affected portion of the bladder cannot then be lifted into the suprapubic wound, as is possible in the case of a benign tumor. In order to gain more room surgeons have cut away the upper portion of the symphysis, or have divided the symphysis and sprung the two pubic bones apart, or have performed temporary resection of portions of the pubic bones; but such extreme measures, while facilitating removal of a tumor, add greatly to the severity of the operation.

If a tumor is situated in the base of the bladder, it is difficult to ascertain to what extent it involves the prostate gland. In other cases it so involves a ureter that a considerable portion of this tube must be resected with the tumor, and its stump sutured in the wound of the bladder. Albarran has recommended ligation of the ureter under such circumstances so as to produce atrophy of the corresponding kidney. This should never be done unless the other kidney is healthy, and the urine which escapes from the ureter to be ligated is clear and free from micro-organisms; otherwise severe pyelitis will follow ligation.

When the tumor has been removed, the gap in the bladder should be closed as nearly as possible by suture and perineal drainage established. The suprapubic incision should not be sutured if the gap in the bladder which follows the resection of the tumor cannot be completely closed; nor if the peritoneal cavity is also opened; nor if a severe cystitis exists. In these serious cases it is better to tampon lightly the vesical cavity and the abdominal wound with iodoform gauze. In less serious cases the wound may be closed upon a drainage-tube; and if the conditions are very favorable, the supra-

pubic wound may be closed completely by sutures in layers, although even in such a case two short drains should be placed in the outer angles of the abdominal wound.

Experiments have shown that if the whole bladder of an animal be removed and its ureters sutured in the abdominal wound, it may live indefinitely. Bardenheuer first performed this operation upon man. The patient died fourteen days later of uræmia. Pawlik transplanted both ureters into the vagina, and two weeks later removed the whole bladder. His patient recovered, and by a subsequent operation the vagina was utilized as a urinary bladder, the urine escaping through the urethra.

Partial resection of the bladder of a woman may be performed through the dilated urethra or through the vagina. The latter method is especially adapted for tumors of the base of the bladder. When the resection has been completed, the wounds in the bladder and vagina should be exactly sutured.

In considering the indications for operations upon tumors of the bladder one should bear in mind that every such tumor brings about the death of the patient sooner or later, although in the case of benign tumors the patient may, except for attacks of hæmaturia, enjoy good health for years. It is therefore not to be wondered at that such a patient refuses to submit to a serious operation. Resection of the male bladder is justified only when a cure by partial resection is impossible. Even in such cases its very great risk will cause it to be seldom carried out. According to Wendel, only 4 patients out of 10 thus operated on survived the immediate effects of extirpation of the bladder.

Removal of the bladder itself can be carried out for the most part extraperitoneally, and does not present great technical difficulties. The disposal of the ureters is the serious question. They have been implanted in the intestine, in the urethra, and in the external abdominal wall. If the lower ends of the ureters are resected with the bladder, it is necessary to implant the stump into something close at hand; thus, into the intestine or rectum. Even if such implantation is temporarily successful, the patient usually dies in a short time of pyelonephritis. No matter how extensively benign tumors may be scattered over the bladder, they can all be removed and their bases cauterized through a suprapubic incision, so that resection of the whole thickness of the wall of the bladder is only justifiable in those rare cases in which the whole mucous membrane is covered with papillomata, as was the case in which Pawlik removed the bladder with success, as stated above.

If there are numerous small papillomata, the surgeon should be extremely careful to remove every one. Even when this is done through a suprapubic incision the results are not so good as one might anticipate. Recurrences are the rule, and that, too, when subsequent cystoscopy has shown that every tumor was removed.

Such recurrences are more likely to occur along the line of incision than in the site of the original tumor. For this reason it is supposed that seeds of a papilloma are planted at the time of operation in the wounded portions of the bladder. In order to avoid this, the author concludes such an operation by a brief application of a 1 : 500 solution of nitrate of silver to the whole vesical mucous membrane. It is yet too soon to state whether or not recurrence can be prevented in this manner. In estimating a recurrence it is not sufficient that the patient go for a year without hemorrhage or other symptoms. It is far better to examine these patients with a cystoscope regularly every six months. If this is done, new papillomata will often be found long before symptoms develop.

The risk of suprapubic cystotomy for benign tumors is not great in uncomplicated cases. The author has operated thus in 31 cases, with only 3 deaths—a mortality of 10 per cent.

The risk of fistula is a very slight one in benign cases. The period of recovery occupies three weeks or more.

The results following resection of malignant tumors are unfavorable. The author has operated upon 36 patients, only 3 of whom are to be looked upon as permanently cured, while 4 suffered from permanent fistula and 4 died from the operation, a mortality of 11 per cent. According to Wendel's statistics of 55 cases, death occurred either immediately or soon after operation in 25 per cent. The risk is greater if the peritoneum is opened at the time of operation, and is still greater if the ureter is to be resected.

Intraperitoneal operation is adapted only to small tumors, such as the recurrences which follow suprapubic cystotomy, although in certain cases tumors as large as an apple have been thus removed. One great advantage of this method is the avoidance of narcosis and prolonged treatment in bed. These points are of importance since vesical tumors occur at a period of life when a serious operation is especially to be dreaded.

Small sections of a vesical tumor may be cut away and the stump cauterized in the surgeon's office. The treatment does not last long, nor is it more painful than a cystoscopic examination. The number of treatments varies according to the size and situation of the tumor. Two may be sufficient to cure the patient, or more than twenty may be required. There is usually no subsequent pain, and the patient can do as he pleases until time for the next treatment. In rare instances treatment is followed by severe hemorrhage. As most of these patients are used to attacks of hæmaturia they are not especially disturbed thereby. The treatment of such hemorrhage is chiefly the administration of large quantities of fluid.

The risk of intravesical treatment is extremely slight. The author has treated 119 patients in this manner without a death, a success which can never be obtained by any other method of operation. The curative results of treatment are also more exact than

those which can be obtained by suprapubic cystotomy. The removal of a tumor by the operating cystoscope is most thorough, since one can cauterize as deep as he wishes, and in a few minutes can cauterize a considerable area.

Recurrences doubtless follow intravesical treatment, but they are far less frequent than after other methods of operating. Every patient should, however, be subjected to cystoscopic examination within three or six months in order to determine whether any tumor remains, or if another has grown. If such be the case, one or two further treatments will suffice to effect a cure. This is another great advantage of the intravesical method.

It is impossible to perform suprapubic cystotomy every year upon a patient, while he can be treated intravesically as often as may be necessary to remove any recurrences. The results of this treatment are most striking when the patients can be seen early; and the author impresses upon physicians the importance of advising cystoscopic examination for every patient who suffers from attacks of hæmaturia.

As one becomes more and more expert in the use of the operating cystoscope he will reserve suprapubic cystotomy for the removal of large benign tumors, and for multiple tumors accompanied by cystitis, a special tendency to hemorrhage, etc.; also for malignant tumors wherever situated.

CHAPTER XXV.

INJURIES AND DISEASES OF THE PROSTATE GLAND.

Anatomy.—The prostate gland is a body which surrounds the vesical end of the urethra, and is therefore situated in front of the bladder. It develops at the end of the third month of fœtal life, in the bottom of the urogenital sinus, from an outgrowth of epithelium, in the same manner as other acinous glands. It grows laterally as well as in the median line. The first twenty to twenty-six little lobules form the side lobes of the prostate. Those which develop later between the wall of the bladder and the seminal ducts form the middle lobe. The prostate is a conical gland, its base being directed toward the vertebræ, and its point toward the membranous portion of the urethra. In size and shape it has been well compared to an Italian chestnut. Its anterior curved surface lies against the anterior wall of the bladder and is fixed in position by the pubic prostatic ligament. Its posterior surface lies against the rectum, to which it is attached by firm connective tissue. The convex lateral surfaces are partially covered by the levator ani muscle. The point of the gland touches the urogenital diaphragm.

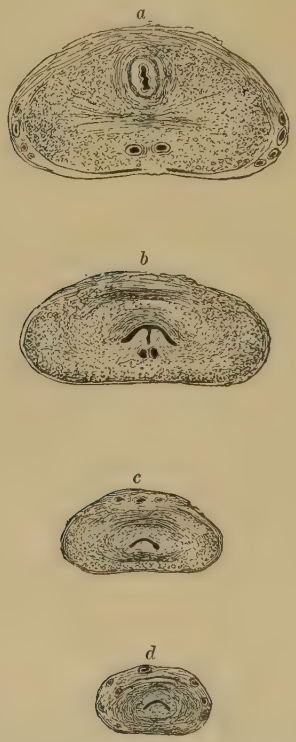
The prostatic portion of the urethra passes in a slight curve through the prostate gland. Above, it lies nearer the anterior surface of the gland, and below, nearer the posterior surface. This is shown by sections of gland made at right angles to the urethra. (Fig. 233 *a*, *b*, *c*, *d*.)

The prostate gland also contains the lower ends of the vasa deferentia and the remains of Müller's ducts—the vesicula prostatica. The seminal ducts converge as they approach their termination in the urethra. The prostate is divided by the urethra into two lobes, although some prostates even at birth contain three lobes.

The prostate is made up of glandular and muscular tissue. The muscular tissue is arranged around the neck of the bladder, forming an external and an internal sphincter. Kölliker, and later Thompson, have emphasized the preponderance of smooth muscle-fibre existing in the prostate. Still, it is without doubt a glandular organ with a definite physiological secretory function. It is made up of twenty or thirty acinous glandular lobules, which are separated from one another by septa. Each has its own secretory duct. These prostatic ducts open laterally, or in the whole length of the prostatic sinuses. The size of the prostate varies considerably. Henle

contends that its transverse diameter is from 2.2 to 4.5 cm. (0.9 to 1.8 inches), while the longitudinal diameter varies from 2.5 to 3.5 cm. (1 to 1.4 inches). Still, there are many prostate glands of considerably larger size which cannot be considered pathological. On the other hand, there are many smaller glands which seem merely like a moderate swelling in the upper portion of the urethra, so that they cannot be detected by a rectal examination.

FIG. 233.



Sections of the prostate cutting the urethra at right angles at different levels from, *a*, near the base to, *d*, near the summit of the gland.

During life the prostate may be examined either through the rectum or through the urethra, but the results of both these methods yield an imperfect idea as to the size and character of the organ. It is possible to recognize by a rectal examination that the gland is enlarged, and to obtain some idea of its consistence, and whether it is uniformly enlarged or irregularly enlarged, and whether it contains a fluctuating area. But exact knowledge is not to be obtained in this manner. Bimanual examination with one hand placed above the symphysis, is of service only in the examination of emaciated persons, and most of the individuals who suffer from prostatic

troubles are stout. Urethral examination of a normal prostate is even more unsatisfactory, although in certain diseased conditions this method of examination yields good results. A combination of the two methods is more satisfactory than either alone. As large a metal catheter as can be passed with comfort is introduced into the urethra and a finger is inserted into the rectum. The point of the catheter can be plainly felt as soon as it has passed the bulb. In this manner one can obtain some idea of the consistence of the gland. If it is necessary to depress the instrument up to the time when urine flows through it, it is fair to assume that there is considerable increase in the transverse diameter of the prostate. Socin measures the longitudinal diameter of the gland in the following manner: Before the bladder is empty he slowly withdraws the catheter until the flow of urine stops as the eye of the instrument passes into the prostatic urethra. He then measures the portion of the catheter which projects from the meatus. The catheter is still further withdrawn until its beak can be felt in the rectum and the portion projecting from the meatus is measured again. The difference between these two measurements, allowing for the distance from the eye of the catheter to its tip, represents the longitudinal diameter of the gland. The endoscope is a great help in the recognition of a normal or abnormal condition of the urethra. Urethroscopy, too, is not difficult to practise, and the information thus gained is valuable and reliable. As the tube is withdrawn the verumontanum is easily recognized by its conical outline with a rounded top. If it is bent to one side, a slit, which is the prostatic sinus, becomes apparent. When the tube is still farther withdrawn, the raphe is noticed, which lies between the openings of the ejaculatory ducts. The vesical orifice can only be seen with the help of a cystoscope.

There are congenital anomalies of the prostate. Absence of the prostate is found only in connection with defects of the urinary and genital apparatus. The sinus pocularis may be occluded at birth. This explains the difficulty experienced by certain male children to urinate during the first few days. When once such a child has passed water under considerable pressure it has no further trouble. It is well in such cases not to wait too long before passing a catheter. The development of cysts in the cellular tissue between the prostate and the rectum may be due to outgrowths from the blind termination of the sinus pocularis.

The function of the prostate and its physiological importance in the formation of the seminal fluid are not definitely determined. Embryologically it must be classed with the sexual apparatus since it is derived from Müller's duct, the remains of which it surrounds. The close association of its ducts with the openings of the seminal ducts also suggests that their functions are allied. In both man and animals the prostate gland develops in the period of puberty.

Hunter has shown that the prostate in animals shrinks in winter, while in spring it increases in size and contains more fluid. These observations, as well as experiments, seem to indicate that there is a co-relation between the prostate gland and testicle.

INJURIES OF THE PROSTATE.

The prostate is so well protected that it is seldom injured even when the perineum is badly torn and crushed. It is injured by falls on sharp objects, less often by gunshot-wounds, 8 times in 3174 gunshot-wounds of the pelvis occurring in the American Civil War. In rare instances a foreign body makes its way into the prostate.

Injury of the prostate gives rise to hemorrhage through the perineal wound or urethra, rarely into the bladder. The urine passed may be mixed with blood. The seminal ducts may at the same time be injured, and their subsequent obstruction may lead to atrophy of the testicle.

A wound of the prostate if simple heals quickly ; but from the nature of the case such a wound is often infected. Hemorrhage may be controlled by gauze, and if there is risk of infiltration of urine free incisions should be made to avert this danger.

INFLAMMATION OF THE PROSTATE.

Acute prostatitis is usually extension of inflammation of a neighboring organ, and especially of the bladder and the urethra, particularly the latter. It is difficult to say how far unwise therapeutic measures, such as the passage of instruments or urethral injections, and how far traumatism, such as long horseback rides, are responsible for the development of prostatitis. These causes cannot be very important, since the gland is situated deeply and is well protected. When it is inflamed, it gives rise to severe pain and a feeling of heaviness and heat in the base of the bladder. The pains are increased by defecation and micturition. The perineum is tender when pressed upon, and rectal examination is also painful. The examining finger feels a hard, tense, tender tumor in the anterior wall of the rectum. Increase in size may be uniform or confined to one side. The introduction of a catheter is very painful and frequently causes hemorrhage ; it therefore usually requires narcosis. In milder, subacute attacks these symptoms may be wanting. Thus a metastatic abscess may develop practically without symptoms until it begins to interfere with the passage of urine.

Either the glandular parenchyma or the muscular tissue may be the seat of inflammation. In the former case inflammation may quickly subside, or it may go on to the formation of multiple abscesses which increase in size, join, and form a more or less lobulated abscess cavity surrounded by fibromuscular tissue and the capsule of the gland. Acute suppuration of the prostate is

accompanied by high temperature and is usually ushered in by a chill. Such an abscess may break into the bladder or rectum, or into the peritoneal cavity. If the fibromuscular tissue becomes inflamed, it may also suppurate. There will then develop an extensive cellulitis which involves the neighboring tissues (periprostatitis). An abscess caused in this manner is easily palpable from the rectum, into which it has a tendency to break. This is the most favorable outcome. If the abscess does not break into the rectum, it may extend to the peritoneum and lead to pelviperitonitis, phlebitis, thrombosis, sepsis, or pyæmia. Gangrene of the penis has been observed as a result of prostatic abscess. The veins of the suprapubic connective tissue and of the wall of the bladder unite laterally with the veins of the prostatic plexus. Therefore the thrombosis may extend to the veins of the bladder, causing a very serious condition. With symptoms of fever and difficult urination, a tumor forms in the lower portion of the abdomen and extends upward toward the umbilicus. As the pus increases, the fever rises and peritoneal symptoms are added. If the abscess is single and the pus is evacuated, the process may be followed by rapid cicatrization. Sometimes it leaves a fistula connecting with the urethra or rectum or opening into the perineum. Such a patient is particularly unfortunate if the abscess opens in two directions and leaves him with a urethrorectal fistula, to which also may be added one or more fistulas opening into the perineum.

Acute prostatitis which does not terminate in quick recovery may pass into a chronic prostatitis; or the chronic form of the disease may develop gradually without a preceding acute attack. Gonorrhœa of the posterior urethra is usually the cause for this. It may also be due to masturbation. Chronic prostatitis may lead to infiltration with round cells, and dilatation of the vessels, and thus to irregular increase in the size of the organ—a prostatic hypertrophy. In other cases, especially when due to gonorrhœa, it may terminate in well-defined abscess cavities which have their own unpleasant sequels.

Symptoms.—The most important symptom of chronic prostatitis is the discharge of a clear or cloudy milky fluid in quantities varying from a few drops up to 10 c.c. (0.3 ounce) in twenty-four hours. It is especially noticeable during defecation if the fecal masses are passed with difficulty. There will then be pain in the urethra, and afterward a feeling of relaxation and exhaustion. The effect of chronic prostatitis upon the general health is considerable, and patients who suffer with it often lose bodily and mental power. Examination reveals an irregular swelling of the prostate and a moderate tenderness on pressure.

Prognosis.—Chronic prostatitis is a disease which does not yield readily to treatment. Its presence is well shown by the three-glass test during micturition. In this manner the secretion may be obtained for examination. The length of time the disease has lasted,

and the amount of hypertrophy of the gland are of importance in making a prognosis. Among the results of long-standing prostatitis may be mentioned tuberculosis and sexual neurasthenia.

Treatment.—The treatment of acute prostatitis should begin with absolute rest in bed and antiphlogistic measures. Cold may be applied by means of an ice-bag placed against the perineum, or by insertion into the rectum of small pieces of ice wrapped in gold-beaters' skin; or a tube may be passed into the rectum through which there is a continuous flow of cold water. If cold makes the patient uncomfortable, hot applications and the use of hot sitz baths should be tried. The diet should be simple and free movements of the bowels should be secured. Pain may be controlled by morphine suppositories or morphine injections. If catheterization is extremely painful and it is considered inadvisable to chloroform the patient, the urine may be drawn off suprapubically through an aspirator. If an abscess forms in the anterior portion of the gland, it may be possible to rupture it into the urethra by means of a metal catheter. In other cases the abscess may be reached through a prerectal incision and opened after the anterior wall of the rectum has been separated by dissection. It is usually impossible to determine the exact situation of the abscess. If the abscess points in the rectum or in the perineum, it should be opened and drained as early as possible in order to forestall the formation of a fistula. Such an abscess cavity should be frequently irrigated. In less favorable cases the abscess breaks into the bladder or strips up the peritoneum of the pelvis. Under such circumstances the surgeon must be guided in his treatment by the symptoms which are present. Sometimes an extensive surgical operation is necessary in order to save the life of the patient. Chronic prostatitis has been treated in various ways. If the prostatitis is due to gonorrhœa, or to stricture of the urethra, or to masturbation, the first aim of treatment should be to remove the cause. The instillation of a few drops of an active remedy, or irrigation through a metal catheter with some astringent solution, has given good results. Cold water may be applied locally by rectal irrigation, and bathing in fresh or salt water is also to be recommended. Winternitz applies cold directly by passing into the urethra a special instrument called the psychrophor. In some cases heat acts better than cold. The rubbing of salve containing iodine or mercury into the perineum and the application of leeches are old remedies whose efficacy is doubtful. Salve containing iodine or iodide of potash, or lanolin, or some silver salt, may be injected into the urethra, or it may be applied by smearing it upon a thick urethral sound. Iodine has frequently been injected into the substance of the prostate with good result, although many surgeons consider this a dangerous practice. Massage of the prostate through the rectum has been advocated by some. In any case it is worth while to pay attention to the accompanying neurasthenia and the

PLATE XX.

Extensive Hypertrophy of Lateral and Median Portions of the Prostate, the Latter Consisting of a Large Sessile Tumor. (Taylor.)

general condition of the patient. On this account treatment at mineral baths is often very successful.

TUBERCULOSIS OF THE PROSTATE.

Tuberculosis rarely affects the prostate, and when it does so other organs, and especially the testicle, are apt to be simultaneously affected. If the disease is confined to a few nodules in the prostate, it will probably not be recognized unless the prostate is examined on account of disease in the testicles or elsewhere. If tubercular nodules have broken down and form an abscess cavity in one or the other lateral lobes, the condition will require operative treatment. Such an abscess cavity is readily evacuated through a curved prerectal incision situated from 1 to 2 cm. (0.4 to 0.8 inch) anterior to the anus. The union between the sphincter ani and the bulb of the urethra is divided and the separation of the urethra is continued by blunt dissection until the abscess is reached. It should be freely opened and drained. This method of treatment is better than to open the abscess through the rectum after division of the sphincter. Unfortunately such a patient is likely to die from extension of the disease even though the immediate effects after operation are satisfactory. Hence it is all-important to treat the general condition of the patient as well as the localized disease.

SYPHILIS OF THE PROSTATE.

There is, of course, the possibility that syphilis may affect the prostate, but such a lesion has not been actually demonstrated.

HYPERTROPHY OF THE PROSTATE.

The most important pathological change of the prostate is hypertrophy. This consists in a hyperplasia of both the glandular and muscular parts of the organ. The form of hypertrophy depends to a certain extent on the degree to which one or the other kind of tissue is involved. If the glandular tissue is chiefly affected, the hypertrophy will be soft; while it will be firm and hard if the muscular element predominates. The organ may be uniformly hypertrophied, or a single lobe may be chiefly affected. In such isolated hypertrophy the middle lobe is less often involved than the lateral lobe. This is especially true of glandular hypertrophy. If the hypertrophy is a muscular one, it not infrequently involves the middle lobe, since this lobe is less rich in glandular elements than the side lobes. If hypertrophied, the middle lobe may be spread out so as to be broader than usual, or it may become elevated and almost pedicled. Such a lobe may extend into the bladder and act as a valve to obstruct the urethral orifice. The more such a bladder

is filled with urine and the more firmly its muscles contract, the more tightly will this prostatic valve be pressed into the urethral

FIG. 234.

General irregular prostatic hypertrophy. Seen from in front.

orifice. One form of retention of urine is produced in this manner. The urethral orifice when looked at from within the bladder will

FIG. 235.

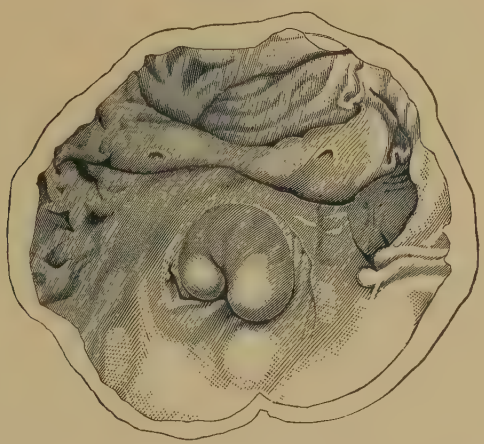
General irregular prostatic hypertrophy in sagittal section.

have the appearance of a letter "Y" with the branches directed backward. In some cases the middle lobe extends still further into

the bladder and gives rise to other deformities of the urethral orifice. (Figs. 233–235.) Such outgrowths of the prostate may become as large as hen's eggs, and may be connected with the rest of the gland by only a slender pedicle.

The supposition that the middle lobe of the prostate is especially likely to hypertrophy does not appear to be warranted by the facts. Thus, Thompson found that all portions of the prostate were involved equally in three-fifths of 123 cases of hypertrophy, while the median portion was chiefly affected 19 times; 8 times the right lobe was chiefly affected and 5 times the left lobe. In 5 cases the side lobes were alone involved, and in 3 others the anterior commissure, and in 3 others the median lobe. These figures represent the results of examinations made upon the dead, and do not altogether correspond with observations made upon the living.

FIG. 236.



General irregular prostatic hypertrophy. Seen from the bladder.

If the fibromuscular structure is chiefly involved in the hypertrophy, the condition is sometimes called myoma of the prostate. This pathological change may go on until the prostate becomes a homogeneous fibromuscular tumor showing atrophy of its glandular structure. The more common condition is for the myoma to appear in isolated nodules or lobes which have a sort of capsule. Such myomata resemble those of the uterus. Rindfleisch states that the commonest form of prostatic hypertrophy is a fibromuscular hyperplasia of the peritubular tissue of certain sections of the gland, which is accompanied by lengthening and branching of the tubules themselves. This condition has been called adenomyoma by Socin.

Whenever the prostate is enlarged, the prostatic portion of the urethra is necessarily altered. Its length is increased so that it may measure 5 cm. (2 inches) or more, and its posterior wall is more

sharply curved, so that it may even be bent at an angle. The opening of the urethra in the bladder is placed forward and upward, leaving a pouch of bladder behind the prostate. The urethra is compressed from side to side and elongated in its sagittal axis by a hypertrophy of the side lobes. This urethral dilatation begins quite suddenly at the base of the hypertrophied side lobe. When the urethra is bent sharply forward by the hypertrophy of the middle lobe, a recess is often formed at the angle which makes the passage of a catheter extremely difficult. If it enters the bladder at all, it must do so by following one of the lateral grooves into which the urethra is divided by the middle lobe. It will thus be seen that the alterations of the urethra are confined to its lateral and posterior walls, while the anterior wall is scarcely affected. The practical point in connection with this is that the surgeon should use instruments so constructed that the beak will be guided into the bladder along the anterior wall.

Socin states that in most cases of hypertrophy of the prostate the internal sphincter is so involved in the tumor that it can no longer be recognized as a firm, well-marked ring. In bilateral hypertrophy the internal urethral orifice is often changed to an irregularly swollen ring in which no trace of the sphincter can be made out. The hypertrophied prostatic tissue lies immediately beneath the thickened mucous membrane. In the posterior commissure there may be found some remnants of the sphincter which serve to join the hypertrophied lateral lobes. This fold forms the "muscular barrier" so often spoken of and which makes the passage of instruments very difficult. It is the seat of many a false passage, especially when the urethra is curved abnormally forward.

The interference with urination leads to further changes of the urinary passages, and especially of the bladder. These changes are similar to those which are produced by stricture of the urethra. First, the bladder passes into a condition of excentric hypertrophy. The intravesical pressure is increased by the retention of urine. Therefore the mucous membrane is distended between the meshes of the muscular framework and diverticula are formed. Later the muscular structure of the bladder becomes weakened by repeated attacks of acute retention of urine. This relaxation is favored by the age of the patient, since the muscular structures are less resistant in older people. As time goes on the bladder loses it contractility and is no longer able to empty itself completely. The portion of the urine which remains within it is called *residual urine*. This urine lies naturally in the lowest part of the bladder, which is situated behind the hypertrophied middle lobe. In this pouch the residual urine may remain for a long time, and predisposes this portion of the bladder to catarrh. If the bladder is greatly dilated and the abdominal walls are relaxed, it may extend over the symphysis and hang down in front of it. As a result there may be kinking of the

PLATE XXI.

Trabeculations and Sacculations of the Bladder. (Taylor.)

urethra which will obstruct the flow of water. This is a comparatively common condition, and one in which it is usually impossible to pass a catheter. If the bladder is emptied by suprapubic aspiration, a prostatic catheter may be passed without difficulty.

Sometimes hypertrophy of the prostate is combined with dilatation and varicosity of the veins. These veins are subject to attacks of congestion whereby the prostate is temporarily greatly increased in size. Such an attack may lead to sudden obstruction of urine. Serious hemorrhage may come from a rupture of the veins of the prostatic plexus.

Etiology.—Guyon is of the opinion that prostatic hypertrophy is caused by arteriosclerosis. This opinion has been variously disputed and confirmed. Many observers have looked for a cause of the hypertrophy outside of the gland itself, and have especially considered the influence of the testicle upon it. It is well known that the development and function of the prostate are more or less closely related to those of the testicle, and certain writers have looked upon prostatic hypertrophy as a physiological senile change in the gland in spite of the commonly observed fact that it does not always occur with advanced age, and is sometimes observed in comparatively young men (forty to forty-five years). Opponents of Guyon's theory also insist that it is incredible that enlargement of the organ should follow arteriosclerosis. They incline rather to the view that prostatic enlargement is a sort of new growth. Geiger advanced the theory that prostatic hypertrophy is a chronic inflammation due to the long-continued presence of a gonococcus. Enlargement of the gland may also follow non-gonorrhœal inflammations, such as diabetic urethritis. There is also a difference of opinion as to the part played by habits of life, congestion of the portal circulation, chronic constipation, etc.

Symptoms.—Hypertrophy of the prostate develops in various ways and gives rise to various symptoms. Sometimes there is first noticed an increased tenesmus. Later this tenesmus may become painful. At the close of micturition there may be dribbling of the urine; or such dribbling may continue unconsciously by day or by night. Some patients have their attention called to their trouble by difficulty in passing urine. They are compelled to make more and more abdominal pressure, and succeed in passing only a small stream of urine, or perhaps only a series of drops. Later there is complete retention with or without apparent cause. When this point is reached, the symptoms become worse. Voluntary micturition is no longer possible, incontinence of urine develops, and the bladder is always full in spite of the fact that urine is constantly dribbling away. This is the so-called overflow of a full bladder or paradoxical incontinence.

Three stages of prostatic hypertrophy have been mentioned: In the first stage urination is difficult, while the bladder is capable of

emptying itself completely; in the second stage there is incomplete or complete retention of urine; and in the third stage there is incontinence of urine with distention of the bladder. In addition to these mechanical symptoms there are others of a septic nature which are chiefly referable to the use of the catheter, namely, cystitis, urethrocystitis, ureteritis, pyelitis, and nephritis.

Diagnosis.—The diagnosis of prostatic hypertrophy can be made by rectal examination, by the catheter, and by examination of the urine. It is often impossible to introduce the cystoscope. If this can be done, direct inspection of the internal urethral orifice may serve to confirm the diagnosis.

In making a differential diagnosis one must consider other affections of the prostate, bladder, and urethra which may be confounded with hypertrophy. Such affections are: chronic prostatitis, new growths or calculi of the prostate or bladder, and strictures of the urethra in so far as they obstruct the passage of urine. The patient should be made to pass his urine into three glasses. If he has chronic prostatitis even the water in the middle glass will always contain typical comma filaments, pus, and perhaps gonococci. A sarcoma or carcinoma situated in the centre of an otherwise normal prostate will give rise to no pathognomonic symptoms; but when the gland has taken on a characteristic irregular nodular shape and hard consistence it is unmistakable. A calculus of the prostate usually forms in the gland. It feels hard while the other portions of the gland are soft, perhaps abnormally so. A vesical calculus can only give trouble in diagnosis if it is of the shape of an hour-glass, and is partly situated in the prostate. Rectal examination and examination with a stone-searcher, will clear up the diagnosis. Tumors of the bladder near the prostate are differentiated with difficulty. The urine should be carefully examined and tumor fragments should be looked for in the sediment.

Treatment.—In the early stage of prostatic hypertrophy dietetic treatment may suffice to do away with the symptoms. When a patient comes complaining of alterations in the passage of urine above described, one should seek to regulate his life and protect him from cold and excesses. The evening meal should be small and free from spices. Fluids should be taken in small quantity. The patient should above all things avoid drinking at meals. Iodide of potassium is recommended by Guyon to be taken two or three weeks in every month for a period of four or six months.

Organotherapy has been many times tried, but the results obtained may be all explained as due to suggestion. If the prostatic hypertrophy is complicated with urethritis, drugs may be injected into the urethra with benefit, or they may be introduced in the form of salves and suppositories by means of special instruments. Parenchymatous injections of iodine and other substances into the tissues of the gland have been advocated by Heine and others, but they

PLATE XXII.

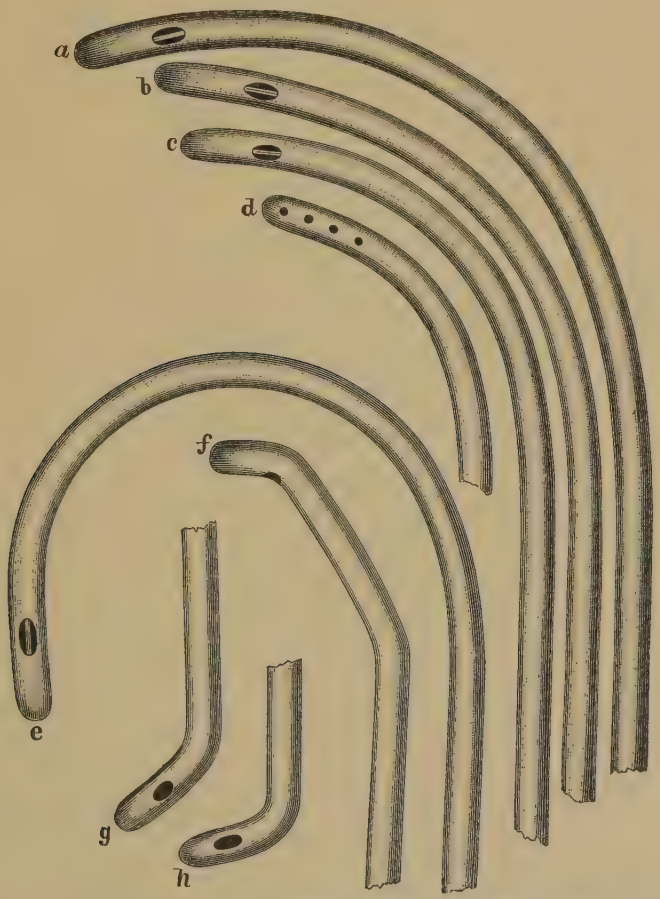
Ascending Pyelonephritis, Cystitis, and Hypertrophy of the Prostate. (Taylor.)

produce at most a temporary benefit, and they may set up abscesses. Massage, electricity, and electrolysis produce no effect worth mention.

The best method of treatment is the regular use of the catheter.

The first symptom noted by some patients is acute retention of urine. This may follow a drinking bout, or some exposure to cold,

FIG. 237



Forms of catheter recommended by different surgeons for use in prostatic hypertrophy: *a*, by Liston; *b*, by Brodie; *c*, by Thompson; *d*, by Guthrie; *e*, curve in which a silk elastic catheter must be held for some time in order to give it a curve similar to *a* when the stilet is withdrawn; *f*, catheter with two angles by Mercier; *g*, by Leroy, angle of 130 degrees; *h*, by Mercier, angle of 110 degrees.

or a too long voluntary retention of urine. The passage of the catheter will relieve the patient, and for this purpose an elastic instrument with a so-called Mercier curve of 110 degrees (Fig. 237) is to be recommended. With a little practice one can almost always overcome the resistance in the prostate, and thus avoid the risk of

employing a metallic instrument. A metallic instrument is very likely to make a false passage. (Fig. 239.) Even if this accident does not occur, irritation of the urethra and hemorrhage are likely to be brought about. Such slight traumatism predisposes to infection. In using Mercier's instrument a delicate touch is all-essential. If the beak meets an obstruction, it may be guided past it by the finger in the rectum. Before giving up this instrument for a metallic one its curve should be variously altered, which can be readily accomplished if it is placed in hot water, drawn over a stilet to which the desired curve has been given, and then immersed in cold water. The new curve thus given the instrument will soon be altered by the warm urethra.

FIG. 238.

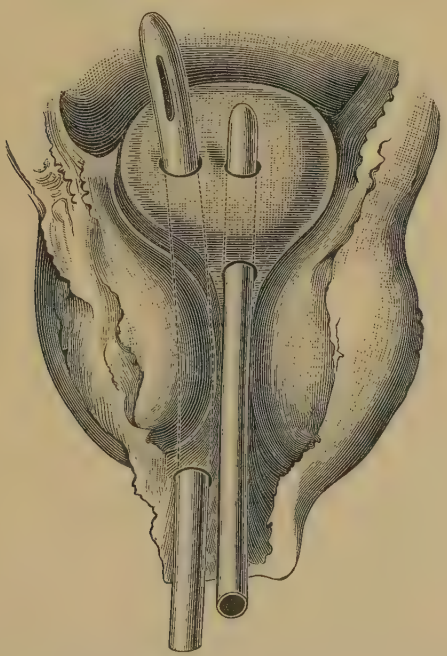
Hey's method of catheterization.

Catheterization is rendered particularly difficult when previous unsuccessful attempts have produced a false passage. If the difficulties of such a condition cannot be overcome by a silk elastic catheter, the use of a silver catheter will hardly prove more successful. Any metallic instrument which is employed should have a prostatic curve. The silver catheter finds its best use in cases of bilateral hypertrophy in which there is a permanent muscular bridge across the posterior lip of the external orifice of the urethra. The handle of the catheter should be deeply depressed between the thighs of the patient and the whole catheter should be slightly pressed backward in order that the beak may push out of the way the muscular point spoken of. If this is done, the catheter often slips into the bladder with a jump. Sometimes a plan recommended nearly a century ago by Hey is successful. He bends the stilet in the so-called prostatic curve, and inserts it in an elastic catheter. (Fig. 238.) The instrument is then introduced as far as it will go with ease. The stilet is then withdrawn about 4 cm. (1.6 inches) by one hand, while the other hand attempts to pass the catheter forward. This gradual withdrawal of the stilet increases the curve of the beak of the catheter, as shown in Figure 238, *a*. By this means the tip of the instrument is directed further forward so that it may succeed in entering the bladder.

If attempts to introduce a catheter are unsuccessful, the patient should not be subjected to prolonged effort of this sort, but his

bladder should be aspirated suprapubically. (Figs. 240, 241, and 242.) Potain's apparatus is the best for this purpose, since it speedily relieves the patient and prevents the risk of urinary infiltration. If the abdominal walls are so lax that the overfull bladder sinks in front of the symphysis and brings about a kinking in the urethra so that catheterization is impossible, aspiration is naturally the only means to relieve the patient. It is also the best treatment for a patient in whom there is already a false passage. The false passage is of itself a dangerous complication. It produces a swelling in the vicinity of the urethra which often prevents the passage of the catheter even by the most

FIG. 239.

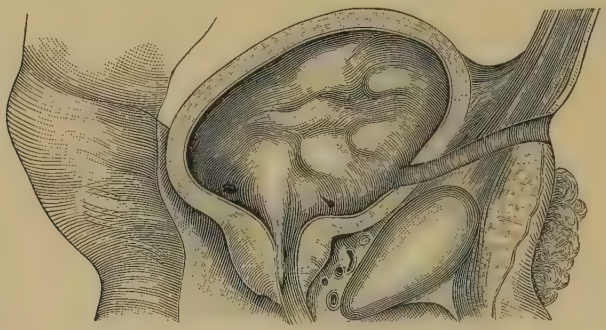


Perforation of the middle lobe of a hypertrophied prostate by a catheter, thus forming a false passage. (Maclise.)

skilful surgeon. Under such circumstances the bladder may be repeatedly aspirated for several days without disadvantage to the patient. Other surgeons prefer to expose and open the bladder suprapubically on the ground that the altered condition of the urine and the wall of the bladder is in itself a counterindication for repeated aspiration. Cystitis and infiltration of urine are not likely to follow the use of very fine needles, and it frequently happens that evacuation of the urine is followed by such diminution of the swelling about the urethra that one is able to pass a fair-sized catheter into the bladder in spite of false passages and alterations in

the urethral curve. If this can be done, the catheter can be left in position until the acute symptoms have subsided. Repeated aspiration is better than puncture, leaving the canula in place. This latter method has, however, given good results. In four or six days a soft rubber catheter may be substituted for the canula.

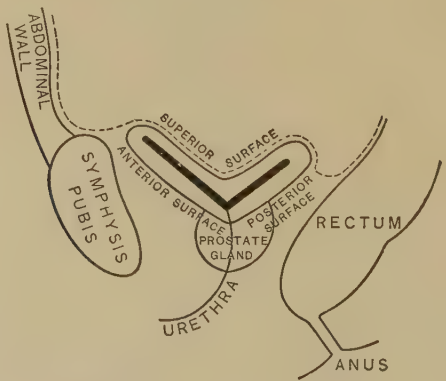
Fig. 240.



Schematic representation of the course of the canal in puncture of the bladder for relieving distention. (Dittel.)

For obvious reasons the greatest care should be taken to make the catheterization as aseptic as possible. In all cases of prostatic hypertrophy there is a predisposition to the development of cystitis. If the bladder has been overdistended, it should be emptied slowly since a rapid evacuation is followed by congestion of the bloodvessels and even by hemorrhage.

Fig. 241.

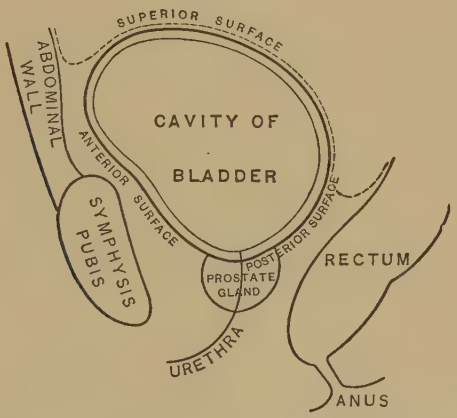


Showing the shape, position, and relations of the bladder when empty; sagittal section. (F. H. G.)

Regular catheterization may be called for not only in acute retention of urine, but also in the chronic form of the trouble. This is in order to free the patient from the residual urine already

spoken of. Even when the condition of the bladder is so much improved that the organ is able to empty itself completely, the patient should occasionally come for examination, and as soon as residual urine reappears catheterization should again be commenced.

FIG. 242.



Showing the shape, position, and relations of the bladder when distended. (F. H. G.)

The urine of such a patient should be carefully examined when treatment is first begun. Even if the usual symptoms of cystitis are wanting it will often be found to contain pus and micro-organisms. If the patient catheterizes himself, he should be thoroughly instructed in the aseptic use of the instrument, and he should provide himself with a new catheter at least every two weeks. If the patient keeps the catheter in a weak solution of permanganate of potassium of about the color of wine, it will be sufficiently disinfected. The complications which may arise from the use of the catheter, such as ureteritis, cystitis, and nephritis, are discussed in the proper sections.

The various forms of operative treatment applicable to prostatic hypertrophy may be classified as follows :

1. The establishment of a hypogastric vesical fistula—suprapubic cystotomy.

2. The relief of prostatic obstruction by operation upon the gland itself. Operations of this character are known as prostatotomy and prostatectomy.

3. A reduction in the size of the prostate by a so-called sexual operation, such as castration, resection of the vas deferens, and organotherapy.

SUPRAPUBIC CYSTOTOMY.—This operation was worked out methodically in 1888 by Poncet. His idea was to establish a permanent vesical fistula in the median line just above the symphysis pubis, hoping to obtain sufficient closure through the pressure of the

recti muscles to make the bladder continent. For the technic of this operation the reader is referred to the section on Cystitis. (Page 189.) By this method one often fails to obtain a continent bladder, and a better plan is to make in the bladder itself an oblique fistula according to Witzel's method. The technic is the same as that for the establishment of a gastric fistula. The catheter can readily be passed through such a fistula which at other times is closed.

The immediate effects of an operation of this character are most favorable. The patient is freed from pain, the annoying vesical contractions cease, and he is able to rest and sleep. These changed conditions affect the catarrh of the bladder most favorably, and if local treatment is desired, it can be carried out through the fistula. The patient's general condition improves. The incontinence which often exists for a few days after operation gradually disappears until the functional condition of the bladder is nearly normal. In catheterizing such a patient the instrument should only be introduced sufficiently far to allow the urine to flow out. As the stream becomes feebler the catheter should not be pushed further in, but withdrawn a little so as to avoid painful contractions of the bladder. The outer end of the catheter should be depressed before the instrument is withdrawn, or closed with the finger so that no air shall pass into the bladder. Such an operation will thus often succeed in bringing a patient back to his usual habits of life. In a few cases there will be a persistent incontinence which requires special apparatus for its control. The indications for suprapubic cystotomy are such serious complications of prostatic hypertrophy as well-marked cystitis, repeated hemorrhage, etc.

Prostatotomy and Prostatectomy.—The incision or excision of the middle lobe of the prostate by instruments passed into the urethra is an operation which was developed by Mercier. His incisor and excisor were constructed like a catheter with a beak made in such a manner that a piece of the middle lobe could be cut or torn away by it. This method of operation was dangerous on account of hemorrhage and risk of infection, and it was materially improved in 1874 by Bottini. Since that time Bottini has repeatedly improved his instrument until now he has one which is very satisfactory. It consists in a galvanocautery which burns deep grooves in the projecting prostatic lobe and thus reopens a free passage for the urine. The instrument looks like a good-sized metallic catheter with a short beak. At the end of the curve is a platinum plate 1 to 2 cm. (0.4 to 0.8 inch) long and 0.75 cm. (0.3 inch) broad which is connected with the lumen of the instrument by wires. The stream of water keeps the instrument cool and prevents it from burning in places where no cauterization is desired. The application of this instrument is simple. It is introduced like an ordinary catheter and then is turned around in the bladder so that the beak points backward and the platinum plate rests against the

prostate. The forefinger of the right hand is passed into the rectum in order to press the prostate against the instrument. The current is turned on and the plate is heated to redness and burns its way into the tissues of the prostate. The surgeon must judge in each case how long the cauterization should be kept up, and how deep a destruction of the tissue is necessary. This will depend partly upon the form of the prostate and partly upon its consistence. The lateral lobe as well as the posterior lobe can be treated in this manner. Before the instrument is removed it must be freely movable in the urethra, otherwise it may tear off some cauterized portion of tissue and give rise to severe hemorrhage.

Freudenberg has recently improved Bottini's instrument in form and electrical construction. Furthermore, his modified instrument is capable of sterilization by boiling water. His instrument is depicted in Fig. 243. It has a cylindrical handle (*Gr*) which, together with the rest of the instrument, is cooled by a stream of water through the tubes (*K*). He has substituted a platinum-iridium knife (*PL*) for the platinum plate of Bottini. This metallic alloy is harder than platinum, and as it offers a higher resistance to the electrical current it can be heated by a smaller amount of electricity. In many points of internal construction it is superior to Bottini's instrument.

In the use of this instrument asepsis is highly important. General anæsthesia is unnecessary. With reasonable caution one can succeed perfectly with the use of cocaine locally. Whenever possible the bladder should first be examined with the cystoscope in order to recognize any alteration in the mucous membrane, and the possible presence of calculi which may exist in connection with prostatic hypertrophy without giving rise to special symptoms. The reason for this is obvious. The calculus lies in a recess back of the prostate and therefore does not interfere with the contraction of the neck of the

FIG. 243.

Freudenberg's prostatic incisor: *PL*, platino-iridium knife; *F*, sheath; *K*, tubes for the inflow and outflow of water to keep the instrument cool; *Sc*, scale; *Gr*, handle; *C*, electric poles; *P*, electric poles; *CS*, contact screw; *L*, electric wires insulated.

bladder. The cystoscope is also useful in showing the direction in which one ought to catheterize the prostate.

Freudenberg warns against cauterization made anteriorly. The gland is thinner on this side, and it is easy to cut through it into the paraprostatic veins and so produce severe hemorrhage. The line of cauterization should not exceed from three-fourths to four-fifths of the length of the prostate. With Freudenberg's instrument it is not necessary to press the prostate forward from the rectum. The catheterization should be made very slowly. A distance of 1 cm. (0.4 inch) ought to require from one to two minutes for its cauterization, so that the whole operation should last from ten to twelve minutes. The bladder should be filled with dilute boric acid solution before the operation. After the operation the patient should have complete rest, and the catheter should not be passed unless it is absolutely necessary. In many cases it is impossible for the patient to pass urine, and therefore it is necessary to draw the water by a catheter for a time. The catheter should not be left in the bladder unless there is hemorrhage or some other complication. It may be necessary to repeat the operation. This will depend upon the condition of the prostate and the amount of cauterization. This operation is indicated in patients who require regular catheterization. It is counterindicated in diseases of the kidney, such as pyelonephritis or pyelonephrosis.

Perineal prostatotomy was advocated by Harrison in 1887. His good results were largely due to the excellent perineal drainage of the bladder thus obtained.

In performing this operation upon the prostate the question arises which must come up with every operation upon the prostate: Will relief of the obstruction suffice to do away with all symptoms? In most cases it is impossible to pass so large an instrument as the excisor into the bladder. In performing Bottini's operation it is important to cauterize hypertrophied lateral lobes as well as the middle lobe. Experience with this operation teaches that in a certain percentage of cases a cure at least for a long time may be obtained in this manner.

A study of the anatomy of prostatic hypertrophy makes it somewhat doubtful whether one ought ever to attempt to remove an enlarged middle lobe of the prostate through the bladder. In any event the diagnosis of enlargement of the middle lobe is not absolutely certain even when made with the help of the cystoscope. If the middle lobe is enlarged, and one succeeds in removing it, there are still the lateral lobes which are frequently hypertrophied, and may serve to interfere with the passage of urine. Thus it is uncertain whether a permanent cure can be obtained in this manner. There are no measures which so far as known will prevent the development of prostatic hypertrophy, and the trouble may occur after a lobe, including a portion of the capsule, has been removed. In this manner a middle lobe may be reproduced after its removal.

If, in spite of these facts, one decides to remove a portion of the prostate through a suprapubic wound, the pelvis of the patient should be elevated, and after the bladder has been opened the portion of the hypertrophied prostate which projects into the bladder should be seized with forceps and drawn into the field of vision. Then with a galvanocautery or a Paquelin cautery it can be slowly cut away. When the enlarged prostate projects into the bladder, forming a ring about the urethral orifice, its tissue may be burned away so as to leave a funnel-shaped depression. The neck of the bladder may then be dilated with Hegar's dilators. After the bladder has been disinfected a catheter is passed through the urethra for drainage and the suprapubic wound is sutured. Such an operation carries with it a considerable risk, and it necessitates keeping the patient in bed for a long time.

Some years ago Dittel performed a number of experiments upon the cadaver, and as a result recommended lateral prostatectomy. He exposed the prostate through a curved incision in front of the anus. dissected the lateral lobes free, and then cut away a large wedge-shaped portion of the gland with a knife or a thermocautery. Such an operation is beyond question a dangerous one. The wound is large and deep, the patient is obliged to keep his bed for a long time, and complications of various sorts may easily arise. Still, this operation is preferable to the total extirpation of the prostate which was previously performed. Thus, Dittel opened, above the symphysis, the bladder of a thirty-two year old man who suffered with hæmaturia and tenesmus. He found the middle lobe much enlarged and removed it He then made an incision to the right side of the rectum, removed the coccyx, divided the capsule of the prostate and shelled it out. The patient recovered. In this case the urethra passed in front of the prostate rather than through the gland, and Dittel was not obliged to dissect the urethra free from the surrounding tissue.

Sexual Operations for Hypertrophy of the Prostate. —The close relation between the testicle and the prostate is well known. This suggested to White and Ramm the idea to cause atrophy of the prostate by removal of the testicles. Working independently, each performed a double castration for this purpose in 1894. This operation had already been performed with apparent success by Sinitzin in 1885 upon a man aged seventy-six years. The procedure is so simple, and the disease which it is designed to cure is so serious, that the suggestion to castrate such patients was widely followed. The mortality proved to be rather high, there being no less than 25 deaths from the operation in 154 cases of double castration. Cures were reported in 42 cases, improvement in 73, and no improvement in 14 cases. Improvement is more likely to follow if the retention has existed only a short time. The general improvement in health, disappearance of cystitis, and return

of voluntary micturition are earlier noted than an atrophy of the prostate. The fatal cases occurred chiefly in individuals in whom there were results of long-standing disease in the kidneys and bladder. When atrophy of the prostate does follow castration, several months are necessary for its production. In addition to local bad effects, such as gangrene of the scrotum, embolism, etc., the operation occasionally produces unpleasant psychic disturbances, such as senile marasmus, melancholy, and other similar troubles which are apparently referable to the loss of the testicles. Such symptoms may also follow unilateral castration. As the effect of unilateral castration upon the prostate is less marked than that of bilateral castration, the former is an operation which ought not to be performed.

The vasa deferentia may be removed while the testicles are preserved. This operation is known as vasectomy. It was first performed by Isnardi, who believed that the results of double vasectomy would be as good as those of double castration. The improvement which follows the operation does not usually show itself until six or eight weeks have elapsed. Reduction in the size of the prostate which follows immediately upon such an operation is due to a lessening of the quantity of blood within the gland. Such a shrinking is more evident in the soft form of hypertrophy than in the harder forms. But true atrophy of the prostate without doubt may follow a resection of the vasa deferentia when no other cause can be assigned for it.

Delagénière recommends luxation of the prostate gland, so that it may no longer press against the internal urethral orifice. He makes a median perineal incision, splits the capsule of the gland, and then with the finger separates the gland from its capsule, and displaces the gland so that it lies between the capsule and the anus. Through a similar incision, Rydygier separates the offending lobe of the gland from its capsule and resects it, while protecting the urethra from injury by means of a metallic catheter.

Vasectomy is much less dangerous than castration. Patients will earlier consent to this operation than they will to castration, and this point will enable vasectomy to make a better showing in results than would otherwise be the case. If the nerves and vessels of the cord are isolated and removed, the effect of vasectomy is heightened. Such an angioneurectomy produces atrophy of the prostate in dogs without gangrene of the testicle. This operation has been three times performed in man with one death.

These sexual operations have not passed unchallenged. Thus Socin demands to know how many of those patients who are described as cured and improved after castration might not have been also improved by a carefully carried out treatment with the catheter. The numerous fatalities should at least make one very careful in selecting cases for operation. Operation should only be performed

if the strength of the patient is good, if there is no inflammation in the urinary passages, and if there is reason to suppose that the function of the bladder can be restored. It is in just such cases that there is good ground to hope that a carefully carried out treatment with the catheter will succeed in effecting a cure. It is also worth noting that many of the patients who were temporarily improved by this operation subsequently became worse.

From all these facts it is fair to conclude that sexual operations, meaning thereby both castration and substitutes for it, have not fulfilled the hopes of their originators. It should be borne in mind that the lack of development of the prostate after castration in early youth is a very different thing from atrophy of a hypertrophied prostate after castration in advanced age. In the one case there is non-development of the organ whose function is suspended. In the other case there is a pathological process. In view, therefore, of the other conditions and of the imperfect results thus far obtained, it may be stated that sexual operations yield no better results than other operative measures, and that, therefore, they should only be performed under special conditions. The same is true of the operation devised by Bier, which may be classed in the sexual group. He ligated the internal iliac arteries on both sides extraperitoneally, hoping to bring about atrophy of the prostate, just as ligation of the uterine arteries accompanied with double oöphorectomy may reduce the size of uterine myomatous tumors. These arteries can be ligated extraperitoneally, but the operation is no light one for a patient with prostatic hypertrophy to undergo. The technic of this operation and that of double castration need not be here described.

Resection of the vas deferens is performed by Helferich as follows: The left hand isolates the vas from the cord and brings it close to the skin of the scrotum. The skin and subcutaneous fascia are divided for 1.5 cm. (0.6 inch). The vas is drawn out with blunt hooks, turned away from the epididymis and dragged downward until it breaks. Usually 8 cm. (3.2 inches) or more can be resected in this manner. The wound is sutured and protected with a collodion dressing. In the writer's experience a properly made suprapubic fistula is the best operative treatment for hypertrophy of the prostate.

The opinions expressed at the International Congress held in Paris, 1900, showed that surgeons were not yet agreed as to the best treatment for prostatic hypertrophy. Resection of the vasa deferentia had more advocates than castration. Some expressed themselves as heartily in favor of Bottini's operation, while others, on account of the frequent recurrence which follows it were less enthusiastic.

PROSTATIC CALCULI.

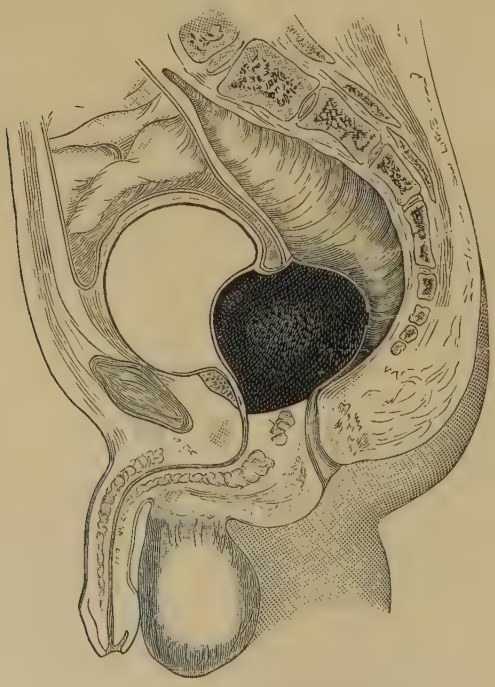
The so-called corpuscula amylacea are formed in the prostate, and as the deposition continues several of them may become joined into

a single calculus. The larger calculi are found in the prostatic ducts. Such calculi originate in a disturbance of the prostatic secretion. They may become impregnated with calcium phosphate or some other salt, in which case they will be hard and white or of a darker color. The symptoms caused by a prostatic calculus are more or less pain and disturbance of vesical function. Their diagnosis is not easy. They are often multiple. A prostatic calculus must not be confounded with a calculus of the upper portion of the urethra, which may grow more or less into the prostate gland.

TUMORS OF THE PROSTATE.

Isolated fibromata may develop in the prostate gland. Such a tumor is firm, has a smooth surface, and is well marked off from the surrounding tissue. It causes no swelling of the gland itself, and therefore produces no symptoms. As was noted above, prostatic hypertrophy may also exist without symptoms.

FIG. 244.



Sarcoma of the prostate. (Burkhardt.)

Sarcoma is a tumor which more often occurs, but in forming an opinion one must not trust to the older statistics, because in them carcinoma and sarcoma are not separated. (Fig. 244.) Grätzer collected 20

cases from recent literature in which the diagnosis of sarcoma is certain, and 7 others in which it is probable. The majority of these cases were observed in childhood and early youth. The disease progresses rapidly to death. In 2 cases the patient lived a year after the tumor was first noted. In the rest of the cases death occurred in from three to six months after symptoms became prominent. One patient, a man aged fifty, was cured by prostatectomy. This rapidity of growth is the most striking symptom of sarcoma of the prostate. The affected gland may reach a size varying from that of an apple to that of a child's head. The larger tumors occur in childhood and the smaller ones in adults and old persons. The physical characteristics of these tumors are similar to those of sarcoma in other portions of the body. Sometimes the whole gland is involved, sometimes only a portion of it. As the disease progresses it may manifest itself in the abdomen, reaching as high as the umbilicus; or it may extend and break through the parenchyma. The commonest form thus far noted is round-celled sarcoma. Other varieties are spindle-celled sarcoma, myxosarcoma, and lymphosarcoma and angiosarcoma. The bladder is frequently involved, less often the rectum. There may be metastases in the lymph-glands or bones, but they are not very common. The lymph-glands in the pelvis are not regularly involved as is so common in the case of carcinoma. Obstruction to the passage of urine is almost always noted. Sometimes there is hæmaturia. A large tumor causes pain through pressure in its vicinity, but the pain is by no means so intense as that caused by carcinoma. Catheterization often fails, and suprapubic drainage must be resorted to. Socin succeeded in removing a tumor of the right lobe which was encapsulated, and the two patients upon whom other surgeons attempted castration died.

Carcinoma of the prostate is usually seen in advanced age. Wolff collected 67 cases, and found that more than one-half of them occurred between the ages of seventy and eighty. He found that the diagnosis was not usually made in life, since the tumor frequently disappears in patients who have suffered for some time with hypertrophy of the prostate. The symptoms of carcinoma are similar to those of hypertrophy, and the chief among them is obstruction to the passage of urine. The rectum is seldom compressed. There are also cases of carcinoma in which no mechanical interference with urethra or rectum is noted. Under such circumstances a primary carcinoma of the prostate will not be suspected until metastases have occurred in other organs, and especially in the bony system. Sometimes there are intense attacks of pain in the region of the prostate, which are ascribed to retention of the prostatic secretion on account of the obstruction of the prostatic ducts. One lobe of the prostate may be enlarged, or the whole gland may be uniformly hard, enlarged, and nodular. Examination may be made per rectum, or, still better, bimanually during narcosis. Cystoscopic

examination does not assist in the diagnosis unless the middle lobe is enlarged, or the tumor has grown into the bladder. The finger in the rectum will often detect a projection on the posterior surface of the gland which contains a certain amount of secretion. This may be pushed out by pressure. The fluid is whitish, resembles pus, and often contains a certain amount of blood. Sometimes the rectal surface of the prostate is perfectly smooth. This is apt to be the case when hypertrophy of the gland exists, or the tumor develops in some portion of the prostate beyond the reach of the finger. Catheterization is usually painful on account of the inelastic cancerous infiltration. As the tumor grows catheterization may become impossible. Metastatic growths if present are usually found in the seminal vesicles and bladder, in the lymph-glands of the pelvis, and in the bony system. It is not always possible to recognize carcinoma of the prostate by a gross examination at autopsy. Furthermore, in making the microscopical examination sections from all portion of the gland will not give the characteristic carcinomatous appearances. Hence many cases of carcinoma have doubtless been looked upon as benign hypertrophy. There is one form of the tumor characterized by glandular growth, the exact nature of which is difficult to diagnosticate, but which leads to early metastases. In carcinoma of the infiltrating type the growth is slower. This kind of tumor gradually involves the lymphatic system of the pelvis. On account of the difficulty of early diagnosis the prognosis is bad. The treatment is usually merely symptomatic. Suprapubic cystotomy may be indicated as a palliative measure.

Englisch describes a cyst of the prostate just posterior to the urethral orifice which contained an albuminous fluid with masses of epithelium and prostatic concretions. The cyst was apparently congenital, and was due to a dilatation of one of the glandular structures of the prostate.

MALFORMATIONS, INJURIES, AND DISEASES OF THE URETHRA.

By Prof. W. KÖRTE, assisted by Dr. RAMMSTEDT.

CHAPTER XXVI.

THE EXAMINATION OF THE URETHRA.

An examination of the urethra and the bladder should always be preceded by a careful personal history of the case, in which particular attention should be paid to the following points: 1. Frequency of micturition; 2. Pain during or after this act; 3. Form of the urinary stream, whether thin, twisted, dropping, or intermittent; 4. Color and other characteristics of the urine; 5. The emission of blood or pus from the urethra. This is supplemented by the chemical and microscopical examination of the urine naturally voided, and inspection and palpation of the urethra and the genitals.

The internal inspection of the urinary canal, or urethral endoscopy, although attempted in the first half of the last century, was not successfully accomplished until Desormeaux in 1853 brought out the endoscope which he had devised. Numerous difficulties attended the use of the instrument at first, but these were overcome by the improved instrument constructed by Grünfeld in 1874, and the later models perfected by Nitze, Oberländer, and Kollmann. At the present time, therefore, endoscopy has come to be quite universally employed.

The endoscopes of Grünfeld consist essentially of a series of metal tubes, of graduated lengths and diameters, the interior being of a dull-black color to prevent reflection. The outer end is expanded so as to form a funnel-shaped opening, and in this way serves to collect a greater number of the light rays from the source of illumination. The latter may be sunlight or, what is preferable, an artificial light, such as an oil or gas flame or the electric light. The tube may then be readily illuminated by the aid of a head-mirror.

Leiter has combined the source of illumination and the mirror in one instrument. In his panelectroscope there is an electric light in the handle supplied with the proper means for making the contacts. Just above the handle is an open metal case containing the lens and

reflecting mirror, and also an arrangement for attaching the tube previously introduced into the urethra, œsophagus, or rectum, as the case may be. Another instrument even more readily handled, is the well-known "Universal" electroscope devised by Caspar.

The endoscopes of Nitze and Oberlander derive their light-supply from a platinum wire fixed in the tube which is rendered incandescent by an electric current. In other respects the tubes resemble those of Grünfeld. This is an excellent means of illuminating the various parts of the urethra, and in order to prevent overheating of the tubes an arrangement for providing a constant current of cooling water has been devised by Kollmann and others.

The current may be derived from accumulators, plunge batteries, or the street supply. Oberlander, Kollmann, and Kümmel have constructed some very practical universal current apparatus.

In both these forms of endoscopy it is possible to carry out a number of the lesser operations in the interior of the urethra, such as cauterization, electrolysis, etc., for which suitable instruments have been devised by the authors already mentioned.

Endoscopy of the urethra is best done after a preliminary anæsthetization of the urethra with a 3–5 per cent. solution of cocaine, injected with the ordinary urethral syringe. For injecting the posterior urethra the Ultzmann syringe is preferable. The tubes, provided with an obturator and thoroughly disinfected, are smeared with sterile vaselin and introduced without force, the penis having been first carefully cleaned. They range in size from No. 21 to 31. Oberlander holds that the large tubes are essential for a successful result. The only difficulty which attends their introduction into an otherwise normal urethra may be at the external meatus, and the latter can be enlarged by means of a knife or with the so-called dilating tube of Oberlander. The patient should be placed on a raised chair or a specially constructed table. In viewing the anterior urethra, a half-sitting posture should be assumed, and for the posterior a horizontal position is necessary.

Skill and experience are both required for a proper interpretation of these endoscopic pictures. In his atlas Oberlander depicted the conditions which are most commonly found in the normal and the diseased urethra, and which are well worth study.

Other methods for the examination of the urethra include the use of catheters and bougies. The various forms of these instruments and their application have been described in the sections on the Bladder and Prostate.

The metal bougies are of two varieties, a rigid form made of German silver or nickeled steel and a flexible form made of pewter. They are bent like an ordinary stiff catheter or have the curve of a Benique sound.

Non-metallic, elastic bougies, of sufficient resistance, are to be preferred, as their employment is less apt to produce injury and is

more agreeable to the patient. These are provided with either cylindrical, button-shaped, conical, or fusiform tips.

All instruments must be thoroughly disinfected before use. In the case of the metal ones this may be best accomplished by boiling or exposing them to live steam; the others should be soaked for some time in bichloride solution of a strength of 1 : 2000 and then energetically scrubbed with the same. The instruments must be warmed and anointed with sterile olive oil, glycerin, or vaselin before their introduction into the canal. The penis, particularly the glans and the vicinity of the meatus, should also be cleaned with soap and water, and washed with sublimate solution.

Among the unpleasant consequences which sometimes follow the employment of catheters and bougies may be mentioned hemorrhage, the production of false passages, and the so-called urethral fever. Bleeding may be caused by the unskilful introduction of instruments, or the use of unnecessarily pointed instruments, producing wounds of the mucous membrane. Slight hemorrhages usually cease of their own accord, and the more extensive ones are ordinarily checked by the pressure of a catheter introduced and left *in situ*.

Pronounced hemorrhage is usually the sign of the production of a false passage. In a normal urethra it occurs but rarely, and then only as the result of unskilful or careless manipulations. It is more apt to take place in the presence of strictures, injuries, or prostatic hypertrophy. The false passage is usually found on the inferior wall of the urethra in the membranous or prostatic divisions, but it may also occur in the pendulous portion. These false passages are spoken of as complete or incomplete, depending on whether they end blindly or after running alongside the urethra for some distance again communicate with the same.

The diagnosis of a false passage must be based on the history and the flow of blood from the urethra. In addition, catheterization is unsuccessful and there is urinary retention. A careful introduction of the catheter discloses a deviation from the median line as soon as its point enters the false passage and a distinct resistance is encountered. At the same time the hemorrhage from the meatus becomes more pronounced, and when the catheter is withdrawn, it is found filled with clotted blood.

In the further course of this complication there may be added inflammation of the periurethral tissue, abscess formation, and sometimes an extensive infiltration of urine, especially if the false passage invades the prostate. In recent cases the treatment consists of the introduction of a catheter into the bladder without entering the false passage, and drawing off the urine. When the retention is not due to stricture, the introduction may often be readily accomplished with a Nélaton catheter, by means of which the opening can be felt and avoided by a slight turn of the instrument. In the case of a stricture it is often necessary to make a number of attempts with catheters

of various degrees of curvature and rigidity before a metal catheter can finally be introduced into the bladder. After the introduction has been successfully accomplished, it is well to leave the catheter *in situ* for a few days, for the desire to urinate soon recurs, and subsequent introductions of the catheter may be more difficult or even impossible.

Prophylaxis, however, is more important than the treatment. The technic of catheterization in stricture, prostatic hypertrophy, and injuries of the urethra, has been described in detail under the appropriate headings. It may be reiterated here that sufficient skill and the use of suitable instruments are the essential factors in avoiding the production of false passages. To one who is not sufficiently skilled, the employment of soft catheters of a moderately large size (No. 24–26 French) is recommended. If after several trials no result is attained, or if only blood issues from the meatus, further efforts should be abandoned and more skilled assistance sought. If the latter is impossible, puncture of the bladder may be done without hesitation. (See page 553.) To this procedure even the surgeon must resort or else perform urethrotomy when all other efforts fail.

Urethral fever is a rather frequent complication which yet remains to be considered. In some patients after the passage of sounds or catheters into the urethra chills are observed, followed by a rise in temperature which disappears within twenty-four hours or may take several days for its subsidence. This condition may usually be ascribed to acute infection through a small abrasion of the urethral mucous membrane produced by the instrument, or in rare cases in sensitive persons to a reflex rise of temperature. In isolated instances sudden death has resulted from cardiac paralysis.

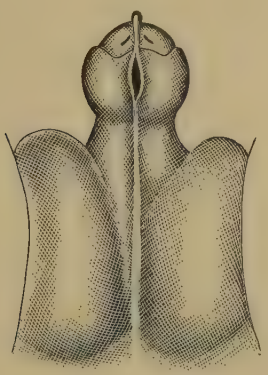
CHAPTER XXVII.

CONGENITAL MALFORMATIONS OF THE URETHRA.

Preliminary Remarks.—In addition to the knowledge of the normal anatomy of the urethra and the penis a brief description of their embryological development is also essential for a proper understanding of the congenital malformations of these organs.

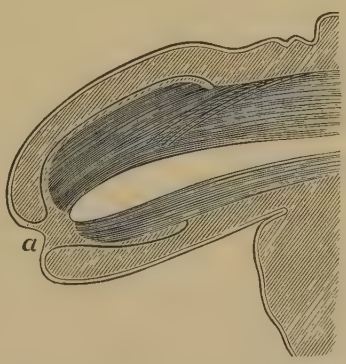
During the sixth week the cloaca, which in the early stages of development is a mere cleft, becomes surrounded by a circular fold, forming the genital ridge, in the anterior part of which there arises the genital papilla. Soon after a furrow is formed on the inferior surface which passes downward into the cloacal cleft. This furrow gradually deepens and becomes enclosed by the so-called genital folds.

FIG. 245.



Fœtus about 8.5 cm. (3.4 inches) long. The prepuce covers about two-thirds of the glans. The urethral groove is in process of development toward the anterior end of the penis, and is continued forward in the epithelial layer of the glandular portion. (Tourneux.)

FIG. 246.



Section through penis, showing the agglutination of the epithelium between the glans and prepuce at *a*.

In the third month the cloaca becomes divided into the anus and the urogenital opening by the formation of the perineal body. During the fourth month the genital papilla elongates to form the penis. The furrow on the lower surface, the urogenital sinus, also takes part in this growth, but sinks deeper and deeper until the overhanging edges unite to form a closed canal, the urethra. (Fig. 245.) It is claimed by Tourneux and several others that the two parts of the urethra situated, respectively, in the glans and the penis proper do

not develop at the same time, as the urethral furrow is found during the developmental stages only on the body of the penis, but not on the glans. The glandular urethra therefore is developed from a wall-like group of epithelial cells which grows forward on the inferior surface of the glans and terminates anteriorly in the form of a tuft.

A crescentic fold of mucous membrane which is usually found in the posterior end of the fossa navicularis, about 12-15 mm. (0.5 inch) from the meatal opening, and includes the entire superior wall, is believed by Jarjavay to afford tangible proof of this formation. Kaufmann, however, considers that this fold is the surviving remnant of a septum which during a certain stage of development existed between the dermal invaginations of the glandular and the penile urethra. (Fig. 246.)

However that may be, both theories undoubtedly explain a number of congenital anomalies of the glandular urethra, such as absence of the glandular urethra and hypospadias, in which the urogenital sinus may remain open at any point.

ABSENCE, PARTIAL CLOSURE, CONSTRICTIONS, AND DILATATIONS OF THE URETHRA, AND DOUBLE URETHRA.

Complete absence of the urethra when a penis is present is extraordinarily rare. Kaufmann has succeeded in collecting only 7 cases from literature, and since then no further cases have been reported.

The total obliteration of the urethra in the form of an isolated fibrous cord has been observed in only a few cases, but partial closures of the passage in all its parts have been seen much oftener. A covering of skin over the external meatus forms the simplest variety of closure. In place of the usual slit-like opening there is seen a thin membrane which is distended by the retained urine, and is very apt to be taken for the layer of epithelial cells which during embryonic life forms an adhesion between the glans and the inner aspect of the prepuce. Probably this anomaly is quite frequent during intra-uterine life, but in most cases it is brought to a spontaneous issue before birth, the pressure of the retained urine bringing about a rupture of the thin membrane.

A deficiency of the glandular urethra, also known as an imperforate glans penis, is marked by a slight depression in an otherwise normal glans, where the meatus is ordinarily situated. This obliteration may also involve the greater part of the penile portion, or it may begin in the posterior portion of the urethra and constitute an atresia of the internal orifice.

These anomalies are usually combined with malformations of the rectum, such as an atresia or a fistulous communication between the rectum and the bladder. Extreme urinary retention, dilatation of the bladder, and often of the ureter and renal pelvis, are common to

these cases. A fœtus affected in this manner ordinarily dies in utero, for, according to Kaufmann, the tensely distended bladder exerts pressure on the umbilical vessels and impedes the fœtal circulation. Unless spontaneous resolution takes place, such an embryo dies and an abortion results during the sixth to eighth month. If the external orifice is covered by thin skin, the latter ruptures; if the closure is firmer, there may result an epispadias or a hypospadias (the mechanical theory of Kaufmann), or a urachus fistula may be formed.

When a living child is born suffering from urinary retention, the extreme restlessness, constant crying, absence of urination, abdominal distention, and the local signs on the penis, are sufficient symptoms for making the diagnosis. A favorable prognosis is entirely dependent on prompt interference.

Where there is a thin layer of skin covering the meatus, it may be readily punctured with a fine probe or a pointed knife. Later, adhesion can be prevented by the introduction of two lateral sutures and subsequent dilatation.

In the case of an imperforate glans, Voillemier recommends the insertion of a needle or a trocar through the glans in order to form a communication with the urethra, and the subsequent dilatation of the canal thus formed with sounds. It is simpler to cut into the urethra back of the glans, when this is possible, and in this way to make a urinary fistula.

A more uncertain diagnosis, and also a more unfavorable prognosis, are afforded by the obliterations which begin in the cavernous or the posterior parts of the urethra. Roser and several others have introduced a knobbed sound, a trocar, or a narrow scalpel along the canal down to the seat of the obstruction, and then cut through the bladder. In a few cases this procedure was attended with a favorable outcome, but the method is not to be recommended on account of the uncertainty of the results and the dangers of urinary infiltration. It is better to make an incision in the perineum, search for the urethra, open the same and dilate the contracted portion, and then introduce a permanent catheter to keep the canal open.

In the three known instances of atresia at the internal orifice the obstructing membrane could be readily punctured with a catheter and the retained urine evacuated from the bladder.

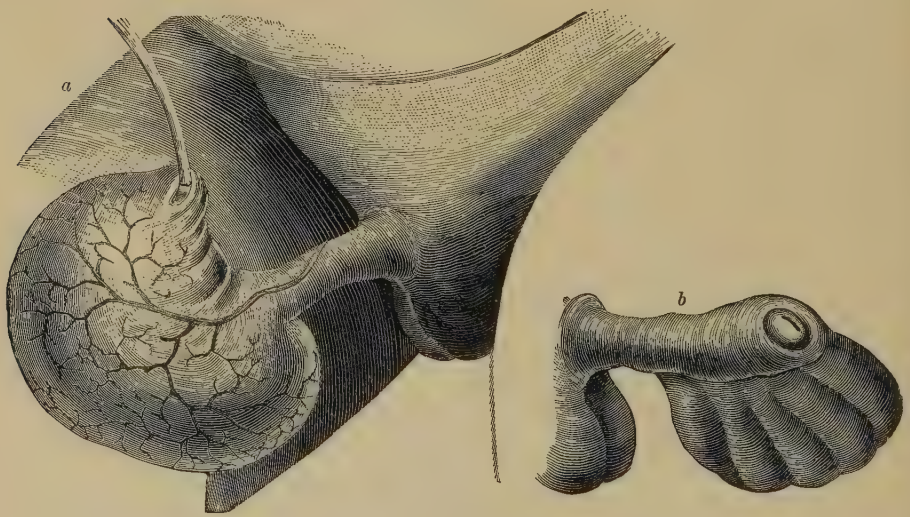
Although the anomalies just described cause severe disturbances during intra-uterine life or at least shortly after birth, the congenital narrowings and strictures may not be submitted to a physician's examination until later in life. Congenital strictures are found in all parts of the urethra. The most common is the stenosis of the external orifice, which is frequently not discovered until catheterization is attempted, when it is almost impossible to introduce even the smallest catheter. In these cases, especially if there is any hindrance to urination, the orifice may be widened by a simple incision with a

blunt-pointed bistoury directed downward toward the frenum. This small wound may be kept open by a strip of gauze and the daily introduction of bougies.

Guyon distinguishes two varieties of stricture in the pars cavernosa, the cylindrical and the valvular. The former, unless they are complicated by hypospadias, are exceedingly rare.

Valvular strictures which cause well-marked disturbances are likewise very rarely found. It is well known that in all parts of the urethra there are membranous valves and pocket-like structures which may at times interfere with the passage of the urinary stream. Thus, a membranous pocket is constantly found at the posterior end of the fossa navicularis, which affords an obstruction, usually readily overcome, when catheterization is undertaken. Segall and Schlagenhaufer have each described a case in which there was a valvular closure in the region of the prostatic portion, with dilatation of the bladder, ureters, and renal pelves. Treatment in similar cases should consist of immediate catheterization with sufficient force to overcome the resistance afforded by the valvular fold. The autopsy findings in the cases just noted show that this method does not, however, effect a permanent cure.

FIG. 247.



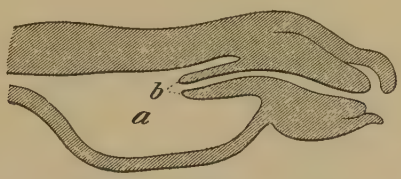
A diverticulum of the urethra: *a* in the distended, and *b* in the empty state. (Laugier.)

A diverticulum is always found on the inferior aspect of the urethra, beginning usually just back of the glans and extending posteriorly, occasionally to the root of the penis. The amount of dilatation varies in size from that a hazelnut to that of a hen's egg, but may be even larger. The interior of the pouch is lined with urethral mucous membrane. Fig. 247, *a* and *b*, show such a case.

Kaufmann traces the origin of these diverticula to a disturbance in the development of the urethra during the period when the penile and glandular portions of the urethra are about to meet (theory of Klebs), but are still separated. The urine from the distended bladder enters the penile portion of the tube, but cannot penetrate the imperforate glans.

Owing to the urinary retention, the urethral walls, and particularly the somewhat thinner inferior portion, become greatly dilated. In certain instances reported by Hüter sac-like prolongations of the urethral mucous membrane have been observed at the junction of the diverticulum and the glandular urethra, and when these become filled with urine, the valvular structures at their mouths prevent

FIG. 248.



Cross-section through a urethral diverticulum provided with a valvular closure: *a*, diverticulum; *b*, valvular outlet. (Hüter.)

its further passage. (Fig. 248.) It must not, however, be assumed that these valves are the cause of the urethral dilatation; they are merely the remnants of the membrane which originally separated the penile and glandular portions of the urethra.

The above condition becomes an inconvenience in so far as the patient is compelled to empty these diverticula during the act of micturition by pressure with the fingers. In some cases, however, there may be incontinence or pronounced difficulty in discharging the urine. The diagnosis is not difficult. The glans and the meatus are both perfectly normal, but back of the latter there is a flabby, sac-like swelling, which becomes tense during urination and imparts a sense of fluctuation to the finger.

Treatment, according to Hüter and Dittel, consists in cutting into the sac, removing the redundancy of its walls, and restoring the urethra to a normal calibre by a careful suture, after excising all the accessible valves and pockets. Judging by the few cases which have been treated, the prognosis is good.

In the malformation known as a double urethra, but formerly falsely designated as fistula of the penis, there is found on the dorsal surface of an otherwise normally formed penis a groove 1 cm. (0.5 inch) or less in depth, which becomes converted into a passage lined with mucous membrane at some point posterior to the glans. This passage may end blindly at the symphysis or may empty into the urethra at some point, while in a certain small number of cases

it has been traced back into the bladder. Formerly it was believed that this canal was the excretory duct of a displaced lobe of the prostate gland (Luschka, Pribram) or a healed epispadias (Klebs), but Englisch has demonstrated from a study of those cases where the tube emptied into the bladder, that the abnormal passage was a true secondary rudimentary urethra. Stockmann has collected 15 instances of this condition from literature. These cases did not as a general thing come under medical observation until the appearance of a purulent secretion, probably a gonorrhœa, at the previously unnoticed opening, attracted the patient's attention. The diagnosis is based on the history as just stated and on local examination with a probe.

The treatment, according to Englisch, consists in total extirpation of the fistulous tract as far as it is possible to trace it. This is the only way in which recurrence may be avoided.

EPISPADIAS.

Epispadias is the term applied to a congenital malformation of the urethra characterized by the presence of an abnormal opening on the dorsal surface of the penis through which the urine is discharged. The penis in addition is usually in a more or less rudimentary stage of development, and when there is a complete fissure the organ is retracted upward toward the symphysis.

Usually there is also found at the same time a fissure of the bladder, and in fact an epispadias without this accompaniment is relatively infrequent.

When the glans is drawn downward, there is seen in place of the urethra a groove lined with mucous membrane. The prepuce is often abnormally enlarged and depends from the inferior aspect of the more or less divided glans in the form of an apron. It is possible to distinguish a glandular and a penile epispadias; in the former the fissure involves only the glans, a rare condition; and in the latter the dorsum of the penis is included. A complete urethral fissure extends down to the neck of the bladder, which may likewise be open and the exposed dark-red mucous membrane may lead to the suspicion that an actual fissure of the bladder itself is present. Associated with this condition there may be a gaping at the symphysis, an occasional absence of the prostate, an incomplete descent of the testes, and almost invariably a double inguinal hernia.

Etiology and Pathogenesis.—The so-called theory of obstruction (Hemmungstheorie) is based on what is known of the processes of development of the male sexual organs. (Thiersch.) According to this theory, an epispadias, with or without exstrophy of the bladder, results from a precocious division of the cloaca into the urogenital sinus and the anus, before complete closure of the pelvic girdle has taken place. In consequence the corpora cavernosa cannot unite to

form the genital papillæ, and as the perineum is developed the urogenital sinus comes to lie on the upper aspect of the corpora, which grow together at a subsequent time. Under these circumstances the urethra remains divided, and if the cleft extends through the various layers of the abdominal wall, the bladder also becomes involved. If closure of the pelvic girdle at the symphysis takes place later, the bladder exstrophy may disappear and only the penile epispadias remains. The mechanical theory (Kaufmann) explains both exstrophy and epispadias by assuming that a rupture of one or both takes place after the bladder and urethra are fully developed, from retention of urine and subsequent overdistention. The retention in these cases

FIG. 249.

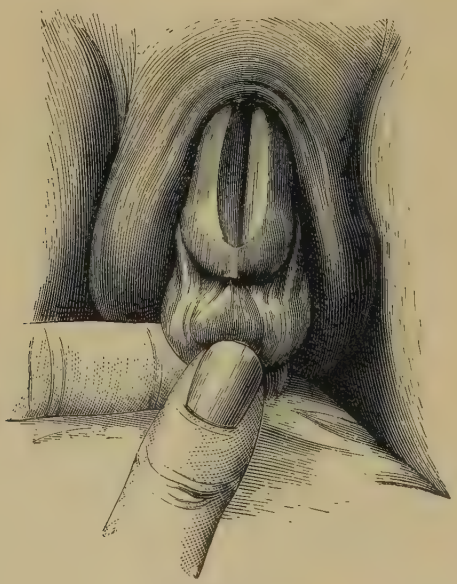
Glandular epispadias.

is supposed to be due to either a complete absence of the glandular urethra or to a delayed coalescence of the penile and glandular portions of the urethra. Kirmisson believes, however, that a tear is not likely to take place through the upper wall of the urethra, as the overlying corpora cavernosa aid in making this the strongest part. Among the other theories that of Guyon may be mentioned, which assumes that an epispadias is due to an inversion of the urethra ; in other words, a reversed hypospadias. Ahlfeld, moreover, believes that the condition is brought about by the rupture in utero of the overdistended allantoic sac, due to some disturbance in the excretory ducts.

Symptoms.—The more extreme this malformation, the greater the degree of functional disturbance. The urine cannot be retained and is constantly dribbling away. It soon causes inflammation and eczema of the scrotum and the neighboring skin. The general health is unchanged, but the patient's mental faculties are often depressed. In later life the sexual functions are always interfered with, not only because of the small size of the organ, but also, even if an erection is possible, because the spermatic fluid cannot be projected sufficiently far into the vagina.

Diagnosis.—From what has just been stated, there ought not to be any difficulty in making a diagnosis. An example of a glandular epispadias is shown in Fig. 249, while Fig. 250 pictures a penile epispadias.

FIG. 250.



Penile epispadias.

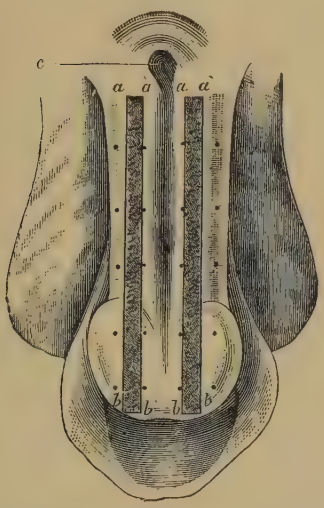
Prognosis.—The prognosis of an epispadias is unfavorable from a functional standpoint unless some form of operative interference is carried out. The numerous methods devised for the cure of this condition aim at restoration of the normal act of micturition, although it is not always possible to do away with the incontinence.

Treatment.—During the past century a large number of methods were proposed for the relief of this affliction. Dieffenbach trimmed the edges of the urethral groove with a pair of sharp scissors and then approximated the raw surfaces by means of sutures secured by fine pins (similar to a harelip suture). A catheter was introduced into the bladder and left there, and the epispadial opening itself was

closed at a later date. The process consists essentially in median closure of the freshened edges of the urethral groove, and has been made more efficacious by the later modifications of Krönlein, and especially that of Duplay.

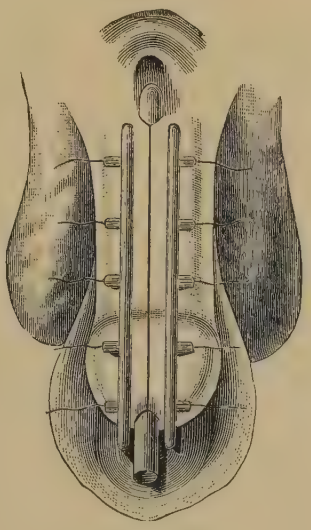
Another method radically different consists in the plastic restoration of the urethra by the formation of flaps from the penis itself, or if its dermal covering is insufficient, from the neighboring parts of the scrotum (Lossen) or the skin of the abdominal wall (Nélaton, Dolbeau). Nélaton first performed this operation in 1859. In Germany Thiersch deserves the credit for the development and application of plastic methods. Successive operations done at intervals is

Fig. 251.



Formation of the new canal: *aa'*, *bb'*, the freshened edges and points for the introduction of the sutures; *c*, entrance to the bladder.

Fig. 252.



Quill suture complete.

the principle which is common to the methods of both Duplay and Thiersch. These are the most universally employed operations and may well be described as the normal procedures.

Before attempting operation, any eczematous condition which may be present should receive suitable treatment, and if the urine is ammoniacal, it should be brought to its normal acidity by regular irrigations of the bladder.

Operation of Duplay.—*First Step.*—The penis should be straightened by making a transverse dorsal incision and then suturing the same in a longitudinal direction. (Compare the operation for hypospadias.) In cases in which the small size of the penis prohibits this procedure, Kirmisson recommends separation of the organ from the symphysis by a deep incision parallel to the upper

border of the latter, cutting through the suspensory ligament and then suturing the wound-margins from above downward in order that future erections will not be interfered with.

Second Step.—After this wound has fully healed and the scar sufficiently stretched, a new urethra is formed from the glans to the abnormal urinary opening as follows: The edges of the urethral groove are freshened by cutting away a fairly wide strip of tissue and the raw surfaces are then approximated and sutured over a sound which rests in a groove. (Fig. 251, *aa'*, *bb'*.) Duplay employs a kind of harelip or quill suture for uniting the denuded edges, as shown in Fig. 252, consisting of fine silver wire stitches introduced about 0.5 cm. apart and held in place by means of perforated shot.

Third Step.—This includes the closure of the epispadial opening which remains, by freshening the edges and suturing the latter together.

Operation of Thiersch.—Thiersch precedes his operation by the formation of a perineal fistula for the purpose of keeping the urine away from the operative field. Although apparently of some value, this procedure complicates the operation unnecessarily and is omitted by most surgeons.

First Step.—Formation of the glandular urethra. The glans is divided practically into three parts by two converging incisions

Fig. 253. Fig. 254. Fig. 255.

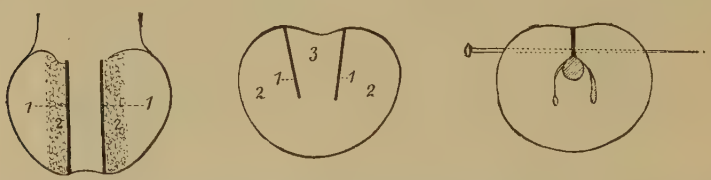


Fig. 253.—Glans viewed from above: 1, 1, longitudinal incisions on either side of the urethral groove; 2, 2, freshened areas on either side of the incisions.

Fig. 254.—The longitudinal incisions as seen in cross-section: 2, 2, outer segments; 3, middle segment.

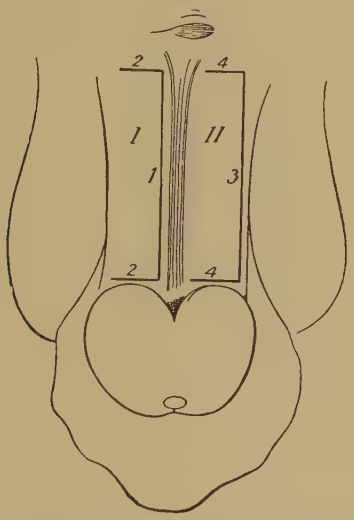
Fig. 255.—Glandular urethra after suture.

which are made on each side of the groove as shown in Figs. 253–255. The two lateral sections are then freshened as indicated and sutured over a sound. The middle section then represents the lower part of the circumference of the new urethra, and from it will grow the complete epithelial lining of the latter.

Second Step.—Formation of the penile urethra. Two long lateral flaps are dissected away on either side of the groove from the subcutaneous tissues, as shown in Figs. 256, *I*, *II*, and 257. The flap with its base next to the groove is turned over so that its epidermal aspect faces the latter, and is then sutured along the line where the other flap was incised. This is then drawn over the first sufficiently to cover the raw surface and sutured. (Figs. 258 and 259.)

Third step.—Closure of the small remnant between the penile and the glandular portions of the new urethra. For this purpose the redundant prepuce which hangs down under the glans may be

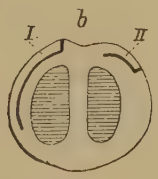
Fig. 256.



Formation of the penile urethra: the superficial flap (*I*) is loosened by means of the incision 1, 2, 2, and the deeper flap (*II*) by means of incisions 3, 4, 4.

employed. It is drawn forward and at about its middle a transverse incision is made sufficiently large to admit of pushing the glans through the opening thus obtained. The edges of the urinary fistula

Fig. 257.



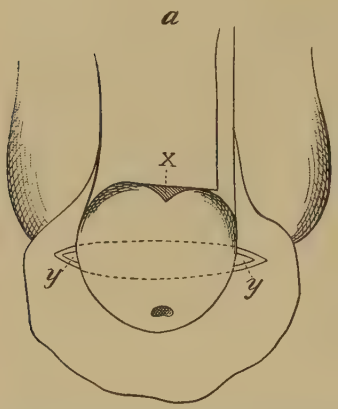
Cross-section, showing the arrangement of the flaps shown in Fig. 256.

are then freshened and the outer layer of the prepuce sutured to the upper border and the inner to the glandular border of the opening. (Figs. 258 and 259.)

Fourth step.—Closure of the infundibulum. Two flaps of skin are freed above and to one side of the funnel-shaped opening. Flap *I* is in the form of an equilateral triangle, its base including about one half of the upper margin of the funnel opening. This flap (Figs. 260 and 261) is turned over in such a way that its epidermal aspect covers the funnel and its edge can be sutured to the lower margins

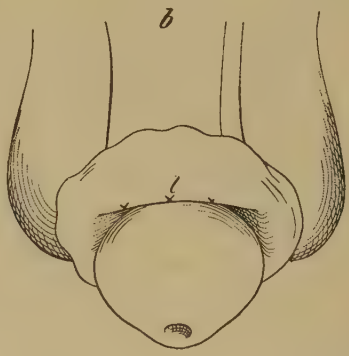
of the opening. Flap *II* approximates a parallelogram in shape with its base corresponding to the line of the right inguinal canal.

Fig. 258.



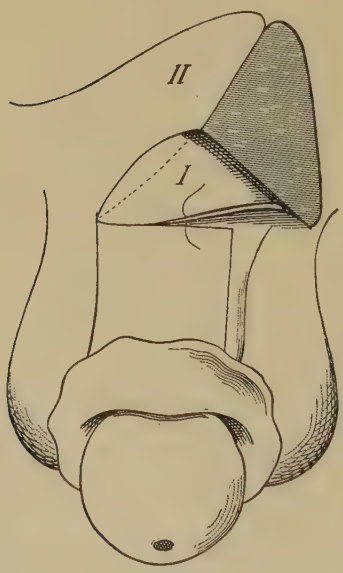
Closure of the fistula, *x*, between penis and glans. The transverse incision through the prepuce is indicated by *y*, *y*.

Fig. 259.



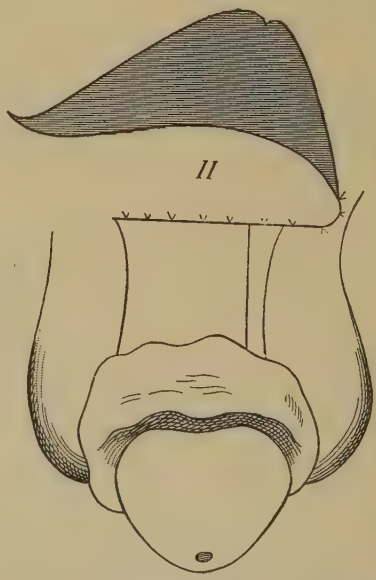
Glans drawn through the opening in the prepuce and sutures inserted.

Fig. 260.



Closure of the infundibulum: flap *I* reversed.

Fig. 261.



Closure of the infundibulum: flap *II* sutured over flap *I*.

It must be freed sufficiently from the subcutaneous tissue to be lifted and made to cover the raw surface of flap *I* and attached to the edges of the latter by suture. The resulting defect in the skin of the

abdomen should be reduced in size as much as possible by suture and the remainder covered with skin-grafts.

Thiersch and others have been able to secure good and lasting results by this method in periods varying from three to four months. The careful approximation and suture of the edges of the wound are the *sine qua non* in all these procedures. But even in the hands of the most skilful surgeons a complete cure is rarely met with after the first attempt, and it is often necessary to do several subsequent operations to close the fistulous openings which are very apt to form.

Other operations, such as those of Hoffmann, Helferich, and Rosenberger, cannot supplant that devised by Thiersch. The least difficult to execute is that of Rosenberger. The edges of the urethral groove are freshened from the glans to the root of the penis, forming a strip of raw surface about 0.5 cm. (0.2 inch) long. Two similar surfaces are then made raw on the abdomen in direct continuity with the latter, the penis is approximated to the abdomen, and the edges of the urethral groove are sutured to the edges of the wounds in the skin of the abdomen—a permanent catheter having been first introduced into the bladder. After the wounds have healed, the penis together with the newly formed urethra is separated from its attachments and at the same time another strip of skin extending from the glans up toward the umbilicus, and of the length and breadth of the penis, is freed from the abdominal wall. The latter flap is at once reflected and used to cover the raw surface on the dorsum of the penis. The resulting defect in the skin of the abdomen is readily closed by sutures. The final outcome is usually good in so far as the formation of the new urethra is concerned, but, according to Madelung, the deformity of the organ, including shortening or bending, is not favorably influenced.

All these methods accomplish restoration of the urethra, but do not cure the existing incontinence. The patients are comparatively improved, but it is necessary for them to carry about a portable urinal or some apparatus for mechanical closure of the urinary outlet.

Trendelenburg has attempted to overcome this difficulty by cutting into and narrowing the posterior part of the urethra, in which the sphincteric closure of the bladder takes place, by means of a series of sutures. The procedure has often met with success.

HYPOSPADIAS.

Hypospadias is the most commonly found congenital malformation of the urethra. By this term is meant a condition in which the urine is voided through an abnormal opening on the inferior aspect of the penis. Three degrees of this malformation are found:

Glandular hypospadias;
Penile hypospadias (penoscrotal hypospadias);
Scrotal hypospadias (perineoscrotal hypospadias).

Glandular Hypospadias.—In this type of malformation the urethral opening is usually found just back of the glans, where the frenum is ordinarily inserted. (Fig. 262.) The prepuce covers only the upper surface of the glans and is often hypertrophied. In place of the urethra there is a furrow running along the inferior aspect of the glans, or in some cases there may not be even an indication of this. Sometimes there is a depression where the meatus ought to be, and back of this the narrowed urethral opening, such a condition presenting the slightest degree of the deformity. In other instances

FIG. 262.

Glandular hypospadias.

there may be a short canal at the end of the glans, which ends blindly, and the actual urinary opening is situated farther back. We thus see that this variety of hypospadias, if of a slight degree, may not be the source of any annoyance unless the urinary opening is small or covered by a fold of skin, which may interfere with the urinary stream. The disturbance is more marked when the glans is flat, bent downward or twisted around its long axis, causing the urinary stream to be directed against the thighs. In some cases there has been observed a fold of skin which starts at the site of the attachment of the frenum and extends down toward the scrotum. It is

known as a *virga palmata* (Fig. 263), and causes marked interference with erection of the penis.

Fig. 263.

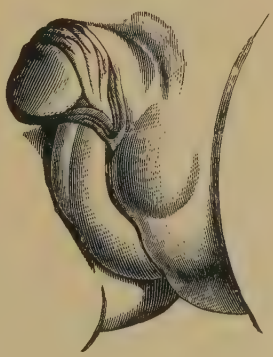
Virga palmata. (Kirmisson.)

Penile Hypospadias.—This condition is more infrequent than the foregoing. The urinary opening is situated farther back, and when it is found at the junction of penis and scrotum it is spoken

Fig. 264.

Seen from the front.

Fig. 265.



Seen from the side.

Penoscrotal hypospadias. (Duplay.)

of as a penoscrotal hypospadias. The opening is usually quite narrow. The missing urethra is indicated by a groove or there may be no evidences of it present. Sometimes there is a blind canal closed posteriorly or at the external meatus. The penis is usually directed downward and to one side, is diminished in size, fixed to the scrotum,

and becomes more dwarfed and stunted as the patient grows older. (Figs. 264 and 265.)

Scrotal Hypospadias.—Here we find the urinary opening along the scrotum, and in the severest cases it is between the latter and the perineum. In a perineoscrotal hypospadias the scrotum is completely divided and the deformity closely resembles a vulva, particularly as the rudimentary penis simulates a clitoris. Between the halves of the scrotum there is found a funnel-shaped opening very like a vagina, lined with a pale-red mucous membrane, at the bottom of which the urinary canal empties. The additional presence of a cryptorchismus completes the picture of pseudohermaphroditism, and it may be a difficult matter to distinguish the sex of the individual. The severer forms of hypospadias are often complicated by other deformities, such as the presence of a cloaca, atresia of the rectum, etc.

Etiology and Pathogenesis.—This condition is due to disturbances in development. As the glandular and penile portions of the urethra are formed separately, a hypospadias in this region may be explained as follows: at some point on the genital papilla the conversion of the urogenital ring into a tube is inhibited, causing the formation of a penile hypospadias, or the glandular part of the urethra fails to develop, resulting in a glandular hypospadias. "It is possible, therefore," says Ahlfeld, "that this anomaly may represent all the stages which normally are found during the closure of the urogenital sinus, including all the steps from the complete persistence of the sinus to those cases where the glans alone remains unperforated and the urethra issues under the fossa navicularis."

According to the mechanical theory of Kaufmann, the condition is explained by assuming that a fœtal rupture has resulted in the formation of an opening in the inferior aspect of the urethra.

Based on observations made in two cases of glandular hypospadias, which presented a circular constricting groove on the glans, Goldmann suggests that the development of normal conditions in the urethra may be interfered with by the formation of amniotic bands which exert an influence similar to that found in other parts of the body.

In conclusion it should also be noted that many observers, including Duplay, Bryant, and Lesser, have observed that hypospadias appeared in successive generations of the same family apparently as an hereditary trait.

Symptoms and Diagnosis.—The lesser grades of hypospadias, and especially the glandular variety, are endured without serious annoyance unless an abnormally narrow meatus, a kinking or torsion of the penis, should be present as a complication. The affliction is a very distressing one, however, when the penoscrotal or the perineal variety is concerned. Urination is rendered difficult, and can only be performed in the sitting posture without wetting the individual. The small size and stunted development of the organ also prohibit co-

habitation and impregnation. The only difficulty in making a diagnosis in a case of total hypospadias presents itself when there is at the same time a retention of the testicles—for in these cases it may be impossible to determine the sex of the person, particularly if the general bodily development lacks the male characteristics.

Prognosis.—The absence of incontinence renders the prognosis more favorable in this condition than in epispadias. If the changes are not very marked, an almost normal condition may be restored by comparatively simple operations. The severe grades of the deformity often require a number of operations before a satisfactory result is secured.

Treatment.—If the passage of urine is retarded by the size of the opening, the latter must be freely incised and kept open if necessary by subsequent dilatations. The milder degrees of glandular hypospadias do not otherwise require interference. If there is present, however, a complete division of the glans, a new urethra must be formed. For this purpose numerous operative procedures have been suggested. Dieffenbach transfixes the glans with a trocar down to the existing urethra and then keeps this canal open by artificial means.

Fig. 266. Fig. 267.

Formation of the glandular urethra after the method of Hacker.

A very practical and superior method is that first suggested by Beck in 1897. It consists of the forward dislocation of the previously existing urethra together with its corpus spongiosum. The glans is first tunnelled by transfixion with a sharp bistuory or by the formation of two small flaps on its lower surface. The urethra having been sufficiently freed from its attachments, is drawn forward and fixed in this canal by sutures. The advantages of the method are that the new urethra is furnished with a corpus spongiosum, soiling of the wound by urine is avoided, and the insertion of a catheter is unnecessary. König and Marwedig both recommend this method. Independently, Hacker and Bardenheuer have devised similar procedures. (Figs. 266 and 267.)

Beck has also successfully extended this method to cases of

penile hypospadias and to instances where there has been a destruction of the anterior urethra of adults by traumatic or ulcerative processes. Otherwise the most suitable procedure in cases of penile and perineal hypospadias are the operations of Thiersch and Duplay done in several stages. In addition to the necessary widening of

Fig. 268.

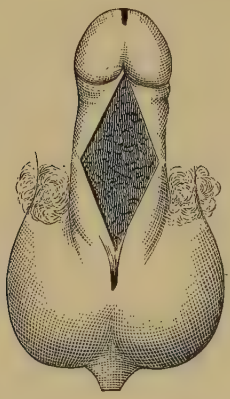
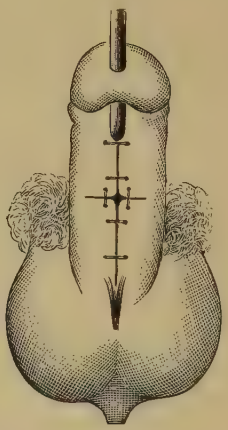


Fig. 269.



Transverse incision of the cord underneath the penis and longitudinal suture of the same.

the urinary opening in these forms, it is also essential to overcome the shortening and bending of the penis which is usually present. The lengthening may be accomplished by the same procedure as already indicated for epispadias, as shown in Figs. 268 and

Fig. 270.

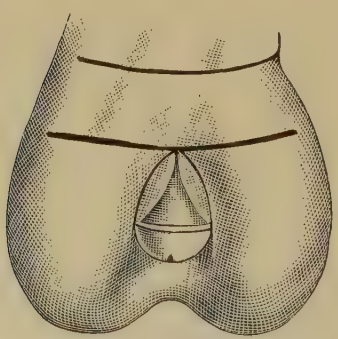
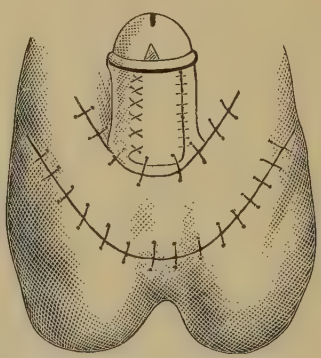


Fig. 271.



Lauenstein's method of restoring the bent penis in hypospadias.

269; or the penis may be elevated by following the method of Lauenstein, who frees the stunted organ from the scrotum and then supports it on a bridge of skin dissected from above and under which the penis is passed. This is well shown in Figs. 270 and 271.

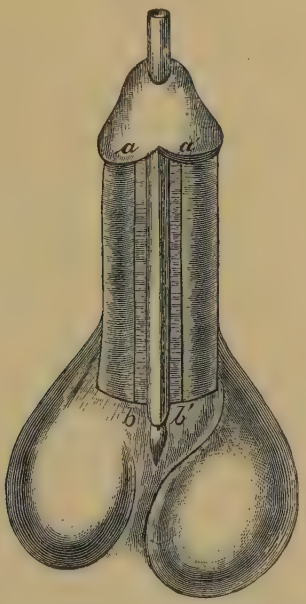
Duplay has modified his operation for penile hypospadias, and it now includes the following steps: The first is a restoration of the penis and the formation of the glandular urethra. The edges of the groove on the lower surface of the glans are freshened and then sewed together over a bougie. If there is much tension, one or two lon-

Fig. 272.

Restoration of the glandular urethra in hypospadias by the method of Duplay.

gitudinal lateral incisions may be added, as illustrated in Fig. 272, *a a'*. The second step is the formation of the penile urethra. Longitudinal incisions are carried alongside the urethral depression a short distance from its edges. At both ends transverse incisions

Fig. 273.



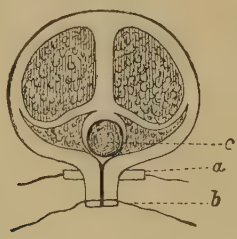
Formation of the penile urethra in hypospadias. (Duplay.)

are made (Fig. 273), forming in this wise four flaps. The two with their bases directed toward the groove, are sufficiently freed to permit their being reflected and sutured over a sound, restoring in this way a urethral canal. The two remaining flaps are then brought over the former and their edges sewed together. (Fig. 274.) The third step consists of the closure of the two remaining openings.

The defect between the glandular and the penile urethra is covered by using the prepuce in the same manner as advocated by Thiersch for epispadias, and the posterior opening is closed by freshening and then suturing the edges.

A large number of other procedures have lately been proposed, some of which have been attended with good results and are therefore worthy of mention.

FIG. 274.



Cross-section of completed plastic operation. (Duplay.)

Landerer, and independently of him, Bidder, have restored the urethra in penile hypospadias in a manner similar to that employed by Rosenberger in epispadias, by taking the flaps described from the scrotum. Landerer commends the simplicity, rapidity, and certainty of this procedure. In selected cases the urethra has also been formed from transplanted skin-flaps. Josserand employed for this purpose a section of skin from the thigh, Tuffier, from the upper arm. In both cases the flap was rolled around a catheter, with the epidermal side turned in, and the whole inserted into a previously made subcutaneous canal and allowed to heal *in situ*. The fistula was closed at a later date. Rochet publishes a similar experience—but he used a flap from the scrotum, to which it remained attached, with its base at the urinary opening. The latter methods are attended by one disadvantage, however, the growth of hair in the newly formed urethra is apt to lead to unpleasant sequelæ, and for this reason it is always well to construct the urethra in these cases from the skin of the penis itself.

Opinions vary as to the proper time for doing an operation for hypospadias. It is advisable in cases where there is a marked deformity of the penis, to correct the same early, if possible during the first years of life, to obviate any further stunting in the growth of the organ. The restoration of the urethra may then be undertaken at any time from the sixth to the tenth year.

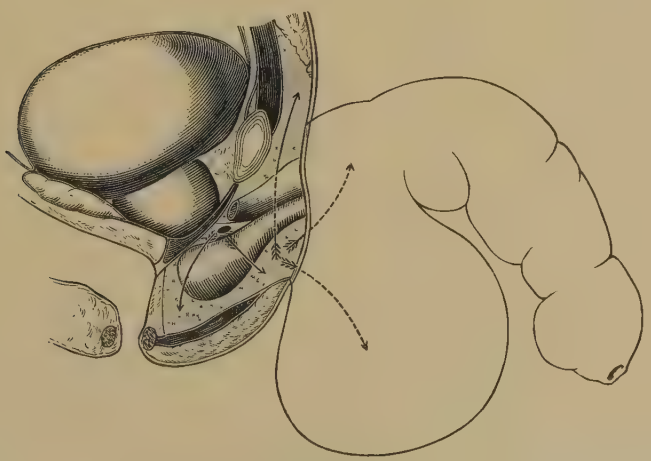
CHAPTER XXVIII.

URETHRAL INJURIES AND THEIR SEQUELÆ.

LACERATIONS OF THE URETHRA.

ASIDE from the injuries due to manipulations, such as careless catheterization, or those produced by fragments of calculi or other foreign bodies which are forced through from the bladder, incised, punctured, lacerated, and bullets wounds of the urethra are comparatively rare. They are usually limited to the pendulous portion, and for that reason almost always combined with lesions of the corpora cavernosa. Accordingly they are more fully discussed in the chapter on the Penis, and only brief mention will be made here of the healing process in clean-cut wounds which invade the urethra in a longitudinal or transverse direction and sever the

FIG. 275.



Showing manner in which urinary infiltration may take place from urethral laceration.

tube to a greater or less extent. Reybard, Kaufmann, Hägler, and others have demonstrated that longitudinally directed wounds of the urethra heal readily under aseptic precautions without suture, and without there being any tendency toward a subsequent contraction of the lumen. Transverse wounds, however, unless sutured are invariably followed by strictures. The application of an exact

suture has resulted in healing without narrowing of the canal, but the possibility of this complication at a future date must always be looked forward to. The treatment of wounds of this class consists therefore in careful suture after the edges of the wound have been freshened if necessary. Where there is also a considerable wounding of the remaining soft parts, it is well to introduce a permanent catheter in order to avoid urinary infiltration. (Fig. 275.) In the case of small wounds the urine should be drawn with a catheter at regular intervals. Healing is apt to be interfered with by erections of the penis, which may be overcome by the administration of morphine.

Opposed to the class of injuries just described are those produced by the application of a blunt force, causing lacerations of the urethra. This variety of injuries may with justice be designated as typical, as they are usually due to the same cause and involve the same section of the urethra, namely, that in the perineal region.

Etiology and Pathological Anatomy.—The most frequent factor in the production of a lacerated wound of the urethra is a fall from a height astride of a firm, narrow object, such as an iron rod, sharp-angled beam, pommel of a saddle, or the saddle or the hind wheel of a bicycle. Somewhat more rare is the injury caused by direct force, such as a blow with a club, kick by man or horse in the perineum, or finally as a complication in fracture of the pelvis in cases in which the person is run over, entombed by wreckage, or squeezed between car-buffers. The mechanism of these injuries has been investigated in corpses by Cras, Terrillon, Kaufmann, and in dogs by Hägler. Their results correspond with those found in the living subject. The perineal portions of the urethra are the bulbous and membranous portions, and these on account of their anatomical position and immobility are firmly pressed against the lower border of the symphysis. An injury may result in contusion and the extravasation of blood, but without solution of continuity of the urethra, or the latter may be partially or completely torn, while the overlying soft parts, particularly the skin, may not afford any evidence of a penetrating wound. If the crushing force is directed against the perineum from before backward, the bulbous portion of the urethra is especially liable to injury, whereas if the posterior part of the perineum near the anus is struck, and the blow is directed forward, as from a kick or a bicycle injury, the laceration is more apt to be found in the membranous portion of the urethra. (Lennander.) In the former class of cases the laceration may, however, involve both portions and the urethra may be crushed to the extent of several centimetres. As a rule it is impossible to gain proper evidence from the history as to the exact direction of the force, and both sections of the urethra are involved in about an equal number of cases.

Rupture of the urethra complicating a pelvic fracture merits

special mention because of the ordinarily unfavorable prognosis and the mechanism of its production. Oberth claims that in the majority of instances a rupture is due to lateral compression of the urethra, the tube being squeezed between the broken rami of the pubes. Kaufmann, Hahn, Nawratzki, and Bramann have observed, however, that in even pelvic fractures produced by a force directed from before backward the urethra may be damaged without being pressed against the symphysis. In exceptional cases the injury is in the most posterior part of the membranous portion, or the urethra may be torn loose in the prostatic segment near the neck of the bladder. In certain instances of fracture of the pelvic girdle with extensive splintering of the fragments, the urethra at the autopsy did not appear to be crushed, but was perforated and torn by the sharp fragments from the broken symphysial bones.

Based on the anatomical findings, Terrillon distinguishes three degrees of urethral rupture: (1) interstitial rupture without injury of the mucous membrane; (2) rupture of the mucosa and submucosa; (3) rupture of the urethra through all its layers. Clinically it is advisable to follow the classification of Kaufmann: (1) contusion of the urethra with or without laceration of the mucous membrane; (2) laceration and opening of the urethra, which may be either partial or complete.

Symptoms.—In a slight contusion of the urethra there is frequently found only a painful swelling and extravasation of blood in the perineal region. Bleeding from the meatus may be entirely absent, and urination is not interfered with unless the blood which has infiltrated the contused area compresses the urethra. If the urethra is partially opened or badly torn, the perineal swelling is more extensive, more painful, and sometimes fluctuates, for the hemorrhage from the lacerated urethral walls and the larger vessels is considerable. In the course of a few hours the swelling and ecchymosis involve the scrotum, the penis, and the neighboring portions of the thighs, giving to the skin a dark steel-blue or purple color. Rectal examination also discloses a painful swelling in the vicinity of the prostate and the neck of the bladder. A sign which points most conclusively, however, to laceration of the urethra, is the appearance of blood at the external meatus, in the form of fluid blood or coagula. But even in the case of an extensive laceration the amount of blood passed may be comparatively small in amount, as the peripheral stump of the urethra may become filled with clots and the blood then collects in the contused area. If there is a slight laceration of the mucous membrane which does not penetrate the wall, no blood may appear or only some blood-stained urine may be passed. No final conclusions should therefore be drawn from the absence or the presence of a small amount of blood, as to the mildness or severity of the injury. An equally important and very disquieting symptom in the majority of the severer cases for the patient,

is urinary retention, which comes on immediately or soon after the injury is inflicted. It is absent only in the slight contusions, is frequent with partial, and always present with complete ruptures, as the quickly forming coagula soon occlude the remaining portions of the urethra or are deposited between the ends of the sometimes widely separated stumps. These symptoms may present great variations in any one individual case, or an injury may at first be accompanied by very mild symptoms, only to be succeeded in a few days by the more severe ones.

Complications.—Although the ordinary contusions usually run an uneventful course, a cure in the case of the partial or complete lacerations of the urethra depends altogether on early and rational treatment. If this is not instituted in time, the most frequent and severe complication is urinary infiltration, by which is meant the extravasation of urine into neighboring tissues. It follows urinary retention, if drainage of the bladder is not provided sufficiently early. The intense burning pain which is brought on by the act of micturition leads the patient to retain his urine for a prolonged period, and he finally squeezes it through the tear in the canal into the damaged tissues, while only a few drops find their way into the anterior urethra.

In severe cases the urine finds its way along the subcutaneous tissues into the scrotum, perineum, penis, and the neighboring regions of the thighs, the groins and the lower abdomen, where it forms an intensely red, painful swelling. The decomposing urine causes putrefaction and disintegration of the connective tissues. The skin, deprived of its blood-supply, becomes gangrenous in spots and sloughs away, and through these perforated areas there is discharged a foul-smelling pus mixed with bubbles of gas, while the general condition of the patient becomes gradually worse. In many cases operative interference is attempted at too late a date and death results from general sepsis, and only in isolated instances does the process slowly resolve itself by the formation of multiple fistulas. What is particularly to be feared is the urinary infiltration which accompanies a fracture of the pelvis, for the urethral laceration in these cases is usually on the distal side of the deep perineal fascia, which, being strong and ordinarily uninjured, offers an effective barrier to the drainage of the resulting purulent material. (Oberst.) The pus then spreads along the pelvic cellular tissue and may lead to thrombosis of the pelvic veins and general sepsis.

Even in cases where the urine can be drained away by either natural or artificial means, some of it may still reach the contused tissues and set up a purulent process by its decomposition. If this area is not very extensive, a localized urinary abscess may result, which is less apt to be followed by urinary infiltration and phlegmon formation.

The end-result of urethral lacerations which heal spontaneously

is a perineal urinary fistula and usually a narrowing of the lumen—a stricture. Even in the case of an apparently simple contusion these after-effects have been observed.

Diagnosis.—In all contused wounds of this region, even those of a slight degree, a possible injury of the urethra should be borne in mind. The meatus must be examined for the appearance of blood; if none is evident, an attempt should be made to express some by gentle pressure on the perineal swelling and penis. The presence of blood is indicative of an injury of the inner wall of the urethra, be it small or large. The ability to pass urine must next be considered. If the urine is voided in a stream of normal color, the mucous membrane of the urethra is probably intact, yet it should be remembered that slight tears need not necessarily be accompanied by hemorrhage. If the patient is unable to pass urine and the attempt causes intense burning pain in the injured region, and the presence of blood can be demonstrated at the same time, there is present a partial or complete laceration of the urethra. In making the diagnosis the only other condition which need be considered is an injury to the bladder, which may also complicate a fracture of the pelvis; but here the perineal swelling is often absent, the catheter readily passes through the urethra and drains off a bloody urine, the spontaneous evacuation of which is not interfered with.

Prognosis.—This depends in lacerations of a severe degree essentially on the early application of rational treatment. Kaufmann has made out the mortality to be about 14–15 per cent., which is increased to 40 per cent. if a fracture of the pelvis is also present. Güterbock asserts that there is one death in every five cases, but includes here the subsequent complications, such as strictures, fistulas, cystitis, and pyelitis.

Treatment.—In order to render the diagnosis more certain it is essential that treatment should be begun by an examination with the catheter. The latter affords information as to the site and the extent of the laceration and at the same time relieves the patient of his most urgent symptom, namely the desire to pass his water. Catheterization should be carried out with the most careful aseptic precautions. It is well to select a catheter of good size, and some prefer a rigid or fairly rigid instrument. Bramann employs at first a Nélaton catheter, because its introduction is less apt to do harm, and with it any resistance in the bulbous and membranous portion of the urethra may be more readily detected. When the latter region is reached, additional care must be exercised in its further introduction. If it is impossible to insert the Nélaton catheter, one chooses a moderately rigid catheter with a Mercier curve, the point of which is more likely to slide along the upper wall, which experience has shown is often intact in partial lacerations of the urethra, while the lower wall is torn. Success may follow the use of a silver catheter having either the usual curve or a Mercier curve. Opinions

differ among surgeons as to the remaining steps in the treatment, whether to allow the catheter to remain in place, or, if one is abso-

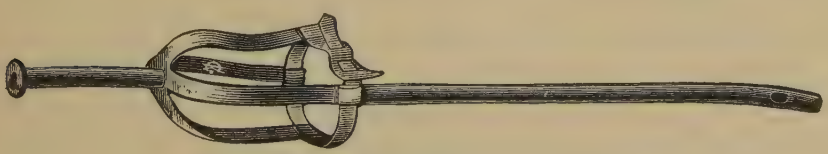
Fig. 276. Fig. 277. Fig. 278.

Soft rubber self-retaining catheters.

lutely certain of a urethral rupture, to make an incision in the perineum. (Figs. 276–278.)

The method about to be described seems to be the one followed by the majority of surgeons. If the injury is recent, and is merely a simple contusion without hemorrhage or retention of urine, and if the catheter cannot detect any resistance in the bulbomembranous portion of the urethra, the patient must be kept under observation, but in the majority of cases healing readily takes place. Later the insertion of bougies may avoid a possible stricture formation. If, on the other hand, there is injury of the mucous membrane, as indicated by the slight resistance in passing a catheter, or when the catheterization is successful only after a number of attempts, the instrument should be allowed to remain *in situ*. This affords a suitable outlet for the urine, and prevents quite effectively the infiltration of urine, at least in large amounts. The presence of the catheter also favors more rapid union of the lacerated urethral walls. Whenever it can be successfully introduced, the catheter should be left in place even if the surgeon intends to perform a surgical operation later. Experience teaches that the catheter in many cases may be readily inserted early, but that after several hours this can no longer be accomplished, because bridges of injured mucous membrane, which have facilitated the introduction, have been torn or have sloughed away, resulting in the production of a complete from a partial laceration. (Kaufmann.)

FIG. 279.



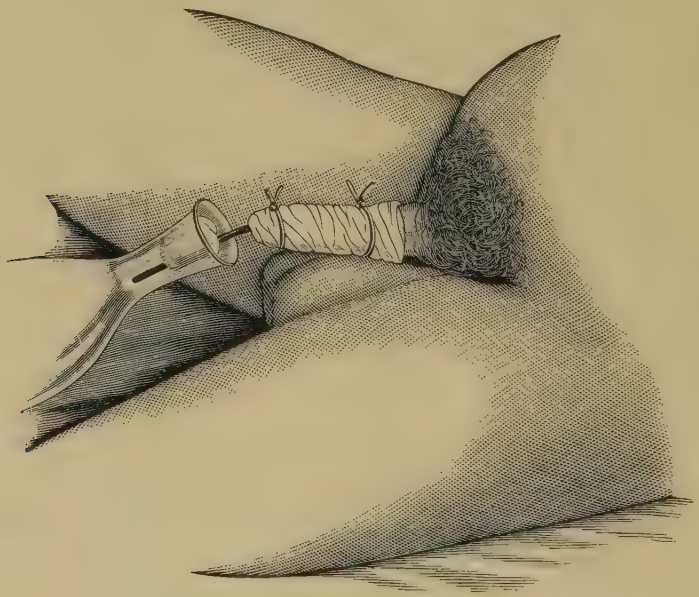
Catheter-holder for retaining soft rubber catheter.

If there is a complete tear of the urethra, the catheter as it passes under the symphysis, passes easily onward and leads the unpractised observer to believe that the bladder has been reached. The absence of the expected flow of urine shows, however, that it is not the bladder which has been entered, but the often extensive area of bruised tissue back of the symphysis. This is especially liable to be found associated with fractures of the pelvis.

The retention-catheter,—sonde a demeure,—must be attached to the penis in such a manner that it cannot become displaced or slip out of the bladder. Dittel's apparatus is the most effective means of fixing a metal catheter. The flexible forms can be attached by strips of adhesive plaster drawn through a small safety-pin in the catheter and fastened to the penis on each side, these strips being secured again by a circular strip passed around the organ. (Fig. 279.) It is advisable to place a small pad of gauze or cotton under the pin, in order to avoid undue pressure

on the glans. The catheter should not be introduced too far into the bladder. A Nélaton catheter may become bent on itself. The correct position may be ascertained by drawing the instrument out from the filled bladder until the flow ceases, then pushing it back sufficiently merely to re-establish a steady flow of urine or irrigating fluid. There are numerous other methods of securing retention-catheters, but those mentioned have proved effective. (Fig. 280.)

Fig. 280.



Retention-catheter with aseptic method of attachment. (Zuckerkandl.)

A permanent catheter should be changed every three or four days and the bladder thoroughly irrigated with boric acid solution in order to keep the almost unavoidable cystitis within proper bounds. Attention must also be paid to the temperature, to the general condition, and to the swelling in the perineal region, in order not to be surprised by any unpleasant complications.

When catheterization is difficult or impossible, and when other signs, such as increased hemorrhage from the meatus, greater swelling in the perineum, higher temperature, speak for a partial or a complete laceration of the urethra, recourse must be had at once to external urethrotomy.

Kaufmann, König, Guyon, and some others do away with the retention-catheter entirely, and advocate in undoubted cases of urethral laceration incision of the canal through the perineum ; claiming that the catheter cannot absolutely prevent urinary infiltration, but rather

favors infection in both urethral and perineal wounds, and after a time usually results in the production of a cystitis.

Kaufmann confirms his assertions by statistics of 44 cases under treatment with the retention-catheter. In one-half of this number the procedure had to be stopped; urinary infiltration took place in 3, perineal abscess formation in 9, and extensive sloughing in 10; 5 of the patients dying from these complications. A point to be noted in passing judgment on these figures is, that cases of urethral rupture for treatment by retention-catheter must always be very carefully selected. If catheterization is done with difficulty, if it fails after two or three judicious attempts, or even if it is successful and the extensive swelling and ecchymosis warrant the belief that the injury is worse than anticipated, and finally if the patient comes under treatment at a time when it is logical to assume that urinary infiltration has already taken place, then the catheter should be laid aside and an incision made immediately. Of the 20 patients seen in the clinic at Halle during the last six years, 12 were treated by the retention-catheter, which was permitted to remain in place for from six to twelve days, and even longer in a few instances. Only one of these patients died. He presented an unrecognized fracture of the pelvis at the symphysis, and being able to urinate normally by the sixth day the catheter was removed. A few days later there occurred a rapid rise of temperature, and an extensive urinary infiltration of perineum and pelvic cellular tissue took place. A thorough incision failed, however, to save life. The autopsy subsequently showed a large defect in the wall of the membranous portion of the urethra and a fracture of the descending ramus of the right pubic bone. Eight patients recovered without attendant complications. In one case there was formed a circumscribed abscess in the perineum during the third week. The remaining 8 patients became infected, and of these, 2 that suffered from pelvic fractures died from extensive cellulitis and sepsis following urinary infiltration.

The technic of urethrotomy is as follows: The incision is carried along the median raphe for about 10–12 cm. (4–5 inches), nearly back to the anus and directly through the perineal swelling down to a catheter or metal sound previously introduced into the urethra. It is possible to expose in this way the entire damaged area and to explore all the pockets, and particularly the site of the rupture. The usually severe hemorrhage may be stopped by tamponade and ligation of the larger vessels. Very often it is a difficult matter to find the ends of the urethra in the infiltrated and bleeding tissues when there has been a complete laceration of that organ. Sometimes the proximal stump can be detected by the more severe hemorrhage which proceeds from it (Oberst), or because by pressing on the bladder urine appears in the opening.

In Bramann's clinic the proximal stump is sought for at once in order to make certain that the flow of urine from the bladder is

unimpeded from the start. Especially in pelvic fractures the end of the urethra may be retracted, torn away from the neck of the bladder, or displaced by the bony fragments, so that the urine, unless proper drainage is provided by means of a catheter, finds its way into the pelvic cellular tissue and the site of the fracture. In such cases it may be impossible to isolate the stump of the urethra, and the proper treatment is then a suprapubic cystotomy and passage of a catheter through the internal meatus. If a fracture of the pelvis is present, it is necessary, in order to avoid septic infection, to make the incision in the perineum as early as possible, and to provide adequate drainage for the extensively injured regions in the pelvis.

Whenever the central end of the lacerated urethra can be isolated, Bramann introduces into it a thick Nélaton or fairly rigid catheter, the other extremity of which passes out through the peripheral portion and the external meatus, and is fastened by strips of adhesive plaster to the penis. If the divided ends can be conveniently approximated, they may be united by a few sutures in the posterior wall. This procedure has the advantage of restoring the continuity of at least a portion of the urethral canal.

Kaufmann, Hägler, and more lately Lennander and Cabot, have recommended a complete circular suture of the urethra, and have obtained good results by this method. If the destruction of the surrounding tissues and of the urethra itself is not too extensive, this procedure seems applicable. Guyon goes a step further and suggests suture of the external wound; but this, as a matter of fact, can only be successful in rare instances, and it seems more logical to tampon the wound in order to provide drainage for secretions which may always be looked for from such contused tissues. Tamponade postpones the healing of the wound for a few days only, and a better result is assured in the end.

When the wound is packed, the after-treatment is simple. The catheter, unless plugged, need only be changed after an interval of three or five days. Frequent irrigations with warm boric acid solution serve to keep its lumen open and keep the cystitis within bounds. The latter usually disappears very quickly when after two to four weeks the catheter is removed.

Some surgeons do not use a retention-catheter, and rely on a subsequent restoration of the lumen of the urethra by the passage of sounds, even in those cases in which the proximal section of the stump cannot be found at operation. König simply packs the perineal wound and allows the urine to trickle down over the wound. After several days the opening in question can be more readily isolated and probed. But König himself admits that a disadvantage of the method is the liability of establishing a tendency to extensive functional strictures during the period of cicatrization. To avoid this he suggests partial suture whenever this can be done.

Whether one employs catheterization or not, the after-treatment

should always be directed against the formation of stricture at some future date. As soon as healthy granulations appear and the perineal wound diminishes in size—that is, in about fourteen to twenty days—large-sized sounds should be introduced. During the first attempts some difficulty may be encountered in entering the proximal stump, especially if the divided ends are widely separated; but a finger introduced into the wound can render great assistance in guiding the point of the instrument. As the wound grows smaller and cicatrizes without the formation of a fistula the patient is soon able to void his urine by the natural channels.

Among palliative measures puncture of the bladder may be noted, but this should only be performed to evacuate that viscus when catheterization has proved unsuccessful. Under aseptic precautions this is not a dangerous procedure and serves a valuable purpose when the means are not at hand for making an immediate incision.

URETHRAL STRICTURES.

Consideration will not be given in this section to the subject of congenital strictures, nor to those narrowings of the lumen of the urethra produced by foreign bodies, calculi, papillomata, or polyps, nor to the strictures which result from the pressure of neighboring tumors or collections of pus (periurethritis).

According to Dittel, the term urethral stricture should be applied to that condition of the urethra in which the lumen of its canal has become diminished in size by a disease-process in the wall. Three main divisions of the lesion are recognized: spastic, inflammatory, and organic strictures.

1. *Spastic Stricture.*—This is due to a spasm of the musculature of the posterior urethra and is usually the symptom of other disease-processes, such as inflammation of the urethra, or of the bladder, or of the rectum (fissure ani). It may also be the result of psychic influences, fright, fear, shock, etc., although this statement is doubted by many. Treatment consists of cold or lukewarm baths, morphine in suppositories, and careful catheterization. If the stricture is due to organic changes, these must be eliminated.

2. *Inflammatory Stricture.*—The cause of this variety of stricture is to be found in inflammation of the mucous membrane of the urethra in combination with swelling and œdema. It occurs most frequently as an accompaniment of acute gonorrhœa, and more rarely with chronic gonorrhœa and chancre of the urethra, and as such does not come within the limits of this discussion. Another condition which may be referred to the same cause is the urinary retention which often follows operation for hemorrhoids, prolapsus ani, and other operations on the rectum. It may be necessary to introduce a catheter as long as the swelling remains.

3. *Organic stricture* is very frequently met with, and is of especial

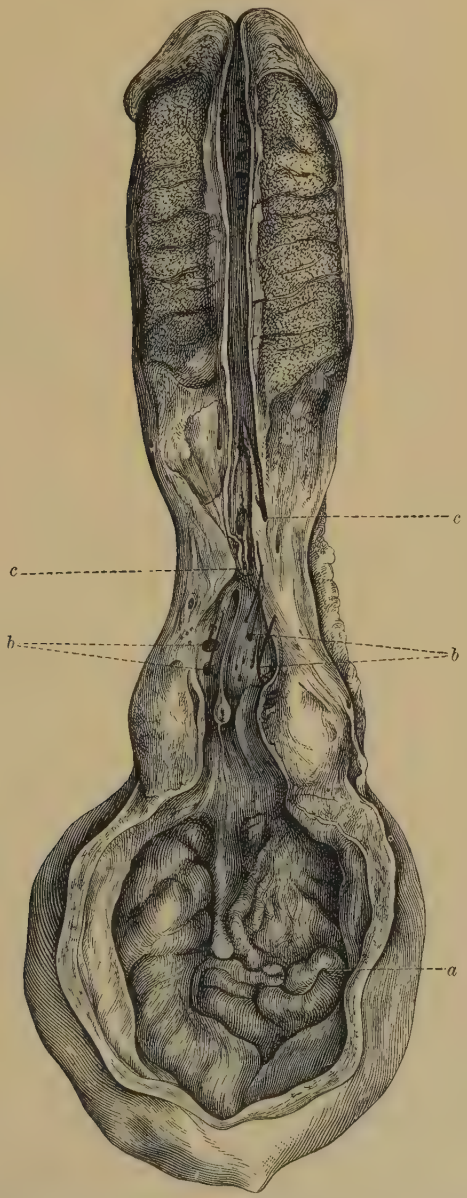
interest to the surgeon. Etiologically it is most convenient to divide such strictures into inflammatory-cicatricial and traumatic-cicatricial strictures. The latter ordinarily result from urethral lacerations of greater or less extent which have been unsuccessfully treated. Less frequently they are caused by foreign bodies, bullet-wounds, false passages, and the extrusion of calculi. The inflammatory-cicatricial strictures are more common, and are in the majority of instances the result of gonorrhœal processes of long standing. In the remainder of the cases they are due to onanism, urethral chancre, diphtheria of the urethra, or the application of caustics to the mucous membrane. Traumatic strictures are most frequently found in those parts of the canal which are usually involved in perineal injuries, namely, in the subpubic portion. Gonorrhœal strictures are likewise usually present at the junction of the bulbous and the membranous portions of the urethra. They also occur in the middle of the pendulous portion and in the vicinity of the external meatus, but are scarcely ever found in the prostatic portion. Thompson claims that about four-sixths of all gonorrhœal strictures are limited to the subpubic portion of the urethra; of the remainder, about one-sixth to each of the other two localities mentioned. Traumatic strictures are almost invariably single, but following an inflammation there are usually three or four constricted points. Both varieties have certain well-defined attributes, which are of prime importance in the diagnosis and treatment.

The extent and importance of a traumatic stricture are in direct proportion to the severity of the injury, depending on whether the urethra has been torn only in part or in its entire circumference. Even in apparently slight contusions gradual constrictions of the urethra have been observed. (Baron.) Where some part of the mucous membrane has remained, a narrow canal may be formed in the new connective tissue, lined with a mucosa. When the urethra has been completely severed, the stumps, particularly the proximal ones, are retracted to such an extent that a spontaneous restoration of the continuity of the canal is impossible. The obliterated lumen of the urethra is then replaced by a cicatricial fibrous cord, while the urine is discharged through a perineal fistula. Gonorrhœal strictures rarely occur in connection with an acute attack, but almost invariably follow severe and chronic cases in the course of a few years. At first the process remains restricted to the surface of the mucosa and results in the formation of flat superficial scars which appear as valves and pockets, but do not interfere with the passage of the urinary stream. Not until the inflammation invades the depressions of the mucous membrane known as Littre's glands, is the submucous and the cavernous tissue involved, and then follow the deeper infiltration and consequent cicatrization. In time the larger part of this connective tissue, as in other scars, is gradually absorbed and the

stricture is firm but relaxed. The length of strictures, unless in exceptional cases, varies from 0.5 to 1.5 cm. (0.2 to 0.6 inch).

Symptoms.—The initial symptom in every constriction of the

Fig. 281.



Stricture in a patient nineteen years of age: *a*, diverticulum of the bladder; *b*, dilated excretory ducts of the prostate; *c*, false passages. (Dittel.)

urethra is a change in the character of the urinary stream. The force and distance to which it can be thrown become gradually diminished, the direction is changed, or it may be spirally turned and divided into several streams. At times there may be mucopurulent discharge from the urethra, which denotes that inflammatory processes are still present. As the lumen of the urethra becomes gradually more constricted, micturition becomes frequent, but the urine is passed in small amounts and is voided with increasing difficulty until a complete evacuation of the bladder is no longer

FIG. 282.

Bougies à boule for exploring the urethra.

possible. The ejaculation of the semen is also interfered with, and is accompanied by painful sensations and occasionally a show of blood. The seminal fluid may also find its way back into

the bladder. In the course of time and very gradually other changes and complications may set in, which cause a number of severe symptoms, and this is all in addition to the general deterioration in body and mind to which the patients are reduced by the constantly increasing dysuria. Even in strictures of a moderate degree there is often a cystitis due to ammoniacal disintegration of the stagnating urine or as a result of the frequent catheterization. A so-called excentric hypertrophy of the bladder with dilatation may be caused by the constant urinary retention. The sensibility and contractility of the bladder therefore gradually disappear until the urine can no longer be voided voluntarily. This is followed by an ischuria, and after the action of the vesical sphincter has been overcome, by a constant dribbling of urine from the overflowing bladder—an ischuria paradoxica. In younger individuals we are more apt to find a concentric hypertrophy with diminution in the size of the cavity of the bladder, and this is particularly prevalent with the rapidly forming strictures. The frequent desire to urinate to which these patients are subjected causes hypertrophy of the bladder musculature, and the prominent interlacing bundles of fibres give rise to the condition known as reticulated bladder. An intense effort is made to empty the bladder, but only small quantities of urine are extruded and the individual does not experience the feeling of having succeeded in accomplishing the act in question. In both varieties of hypertrophy there may be a bulging out of the bladder-wall at one or more points, leading even to the formation of diverticula. In exceptional cases of excentric hypertrophy with dilatation, rupture of the bladder has been observed at an ulcerated spot. The urinary infiltration which follows soon leads to a fatal issue. In Fig. 281 are shown the complications rendered possible by severe strictures: hypertrophy of the bladder with the formation of diverticula, distention of the urethra and the mouths of the glands directly back of the stricture, and the formation of false passages. The dilatation and the vesical inflammation may extend to the ureters and renal pelvis and bring on a pyelonephritis, the most frequent cause of death in patients afflicted with a stricture. (Compare the chapters on the Bladder and Prostate.)

Attention must also be directed to the inflammatory processes which may be present in the stricture itself or immediately back of it. The frequent catheterization induces irritation in the stricture and at times false passages may be formed. But particularly in the region posterior to the constriction there is very apt to be ulceration due to the action of the retained stagnating urine, and this in severe cases may lead to urinary abscess, infiltration and fistulas. These abscesses and fistulas are most frequently formed in the perineum, near the anus or the rectum, and in extensive infiltrations they may be localized at more distant points, such as the scrotum, the inner

side of the thigh, etc. Incidentally, inflammatory processes in the vas and the epididymis may also be present.

The increasing interference with the urinary stream may lead to a dilatation of the urethra at one or more points. Thus immediately back of the stricture there may be an enlargement approximating in

Fig. 283.

Kollmann's urethrometer and dilator.

Fig. 284.

Otis' urethrometer with articulated tips.

size the diameter of a finger, together with dilatation of the lacunæ of Morgagni and the excretory openings of the glands in this region, including the seminal vesicles, the prostatic ducts, and Cowper's glands. This gives a reticulated appearance to the walls of the

urethra without causing hypertrophy. These dilatations may lead to the formation of diverticula, with numerous small crypts and pockets, which are all furnished with a membrane resembling the mucosa. The stagnating urine may cause a secondary inflammation with ulceration and perforation of the walls and the formation of urinary fistulas.

Diagnosis.—The diagnosis of this condition is usually evident from a careful history of the case and from the symptoms described. Acute inflammatory diseases, prostatic hypertrophy, and vesical calculi must be excluded. Urethral concretions and the rarely occurring neoplasms, such as a carcinoma, may closely simulate a stricture. In order to determine the site and the extent of the constriction, even if the fact of its presence is made evident by external palpation, an instrumental examination is necessary. For this purpose rigid catheters or bougies may be employed, and it is well to begin with a catheter which corresponds to the normal calibre of the urethra and then insert progressively smaller numbers until the stricture can be passed. In nervous patients it is advisable to inject into the urethra a solution of cocaine (from 3 to 5 per cent.) in order to produce a local anæsthesia and to allay the fears of the patient. Practical instruments for examination are the exploratory sounds devised by Güterbock, with a button-like end, and the bougies à boule, with a tip shaped like an onion. (Fig. 282.) König recommends the Roser metal sounds, which are also provided with a button at the end of a tapering shaft. After some practice it is not a difficult matter to determine by the resistance which the tip of the instrument encounters on introduction and withdrawal the extent, the degree, and even the form of the constriction, whether circular or valvular. Two varieties of stricture may be distinguished, permeable and impermeable; but the latter can only be so designated when the finest horsehair bougie cannot be introduced in the presence of urinary retention. In fact as long as the narrowest constrictions are available for the passage of urine it is not logical to speak of impermeable strictures. In many cases it is possible to enter the bladder with one of the fine filiform French bougies. These vary in diameter from 0.3 to 1.5 mm., are elastic and yet sufficiently resistant, but neither so sharp nor so rigid as the whalebone bougies, which should be discarded. In using the filiform bougies it is sometimes possible to attain a successful result in difficult cases by introducing a number of bougies (six to eight) alongside each other down to the seat of the stricture, like a bundle of arrows in a quiver. While an assistant holds the bundle, trials with one after the other of the bougies often result in one of their number finally entering the bladder. Kümmel has often been able, after other methods have failed, to introduce a fine probe through the stricture with the aid of the endoscope. The exact calibre of the urethra may be determined by a urethrometer.

(Figs. 283 and 284.) Such an instrument will not pass a narrow stricture, however.

Prognosis.—The prognosis varies with the age and the degree of the stricture. In recent strictures it is usually favorable, but where there are secondary changes present in the bladder and kidneys the outlook is more doubtful. Early, energetic, and long-continued treatment may exert a well-marked beneficial influence.

Treatment.—Numerous methods have been devised for the treatment of urethral strictures, and new suggestions are being constantly brought forward. This multiplicity of procedures is a good indication of the great difficulties which have to be overcome in the therapeutics of this condition. Treatment must, of course, be purely mechanical, and has been divided by Englisch as follows:

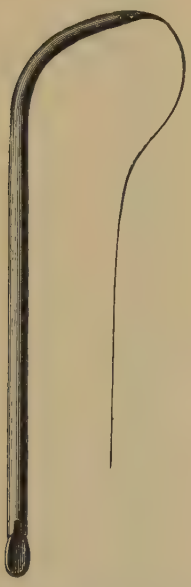
I. Bloodless operations:
  A. Dilatation:
    a. Gradual:
      1. Temporary.
      2. Permanent.
    b. Forced:
      1. Forcible cauterization.
      2. Dilatation by dilators.
  B. Cauterization.
  C. Electrolysis.

II. Bloody Operations:
  A. Internal urethrotomy.
  B. External urethrotomy.
  C. Excision of the scar, with or without suture.

In the majority of strictures where there is no urinary retention gradual temporary dilatation is usually indicated, and should be the first procedure attempted. It consists of the introduction into the urethra of catheters, sounds, or bougies, beginning with a size which can easily be passed through the stricture. In severe cases this may necessitate the use of the lowest numbers, and even horsehair. Elastic bougies with button-shaped ends are chiefly employed for this purpose, but Roser's bougies and various other models may also be used. These procedures often require a great deal of skill and patience on the part of the examining physician. Each sitting should occupy about ten or fifteen minutes, depending on the condition of the urethra and the patient, and should be repeated at intervals of one or more days. The size of the sounds may be gradually increased with each treatment, the last number which had been previously passed being used first. Care must be taken to avoid pain and hemorrhage. The cure is considered complete when No. 23 to 25 French can be readily passed, but the patient should be kept under observation in order to prevent recurrence. In producing permanent dilatation the same instrument, or, what is preferable, a catheter is introduced and allowed to remain in place for several hours or an entire day. This

instrument is then succeeded by one of a larger calibre. (For the technic and fixation of the retention-catheter, see page 595.) This procedure is especially adapted to strictures which are passed with difficulty, when there is more or less urinary retention and dribbling, and when it is even a matter of satisfaction to be able to evacuate the bladder. At the same time a gradual dilatation of the stricture may be secured, for it is claimed by Güterbock that the presence of the catheter makes the tissues of the stricture softer and less resistant. Rapid, forcible dilatation of strictures as recommended by Le Fort, and suggested even earlier by Maissonneuve, depends on the same process, although it is essential that the narrow

Fig. 285.



Dilating bougie with exploratory probe. (Le Fort.)

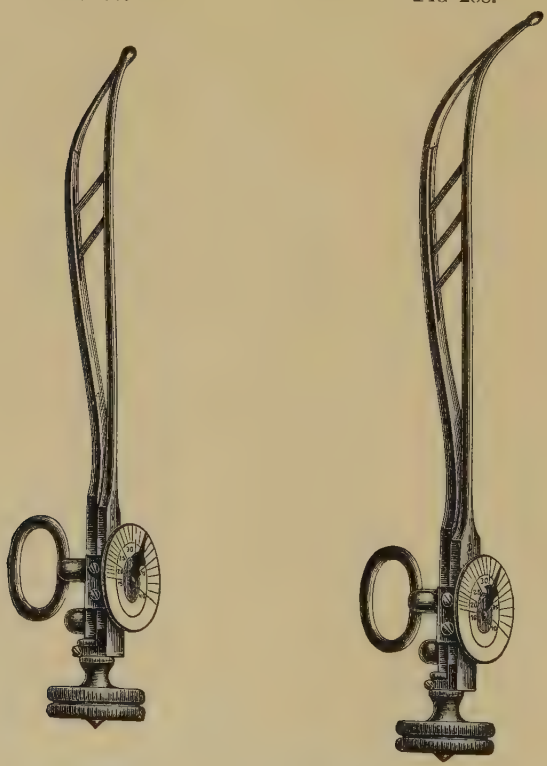
Fig. 286.

Metal sound with Benique's curve and furnished with detachable flexible probe.

constriction must allow the passage of the filiform bougies. These instruments have been constructed by Le Fort so as to be very flexible and yet capable of withstanding a certain degree of resistance. They are fastened to the end of a metal armature which is provided with a screw thread, and may be attached to the extremity of a specially constructed catheter. A series of the latter are provided, graduated according to the French scale. (Figs. 285 and 286.) The presence of one of these bougies for twelve to twenty-four hours causes an inflammatory softening of the stricture-tissue, so that a catheter screwed to its end may be readily passed through the stricture, and as the bougie is pushed forward it simply rolls up in the bladder.

In introducing the larger catheter force should never be used, but if there is any hemorrhage or any resistance is encountered, further efforts at dilatation should be at once abandoned. In order to maintain the result obtained by this procedure the catheter or bougie may be left in place. Bruns has completed this forced dilatation in one sitting under general anæsthesia without first leaving in place a catheter for a preliminary softening. Forcible catheterization, or forcible passage of sounds, or tunneling in cases of partial obliteration of the urethra, are methods of procedure not to be recommended.

Fig. 287. Fig 288.



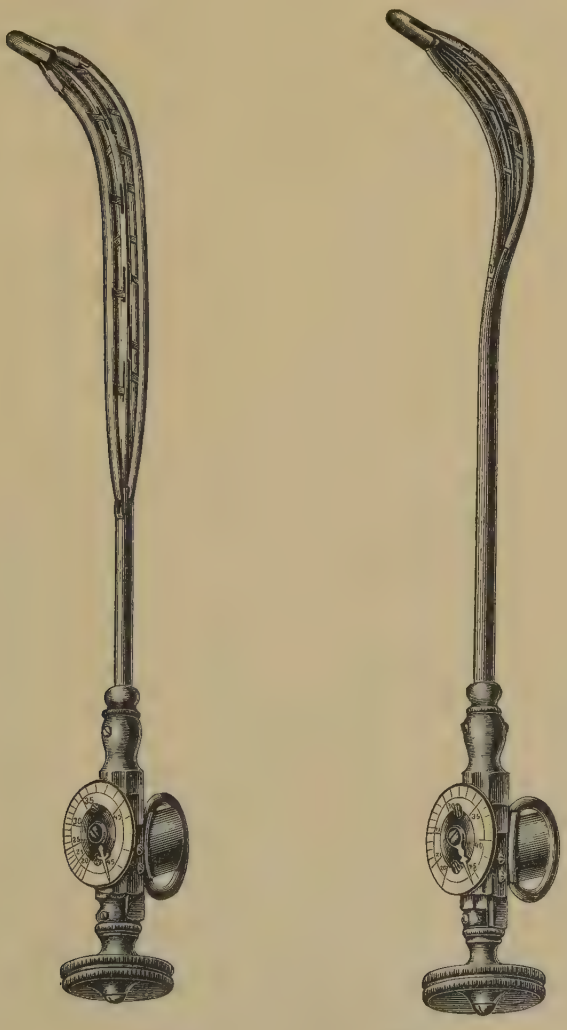
Dilators with various curves. (Oberländer.)

Forcible dilatation or divulsion of a stricture is the stretching and breaking of infiltrations, either superficially or subcutaneously. This may be accomplished by the use of a specially constructed dilator. Several forms of the latter are shown in Figs. 287–290.

Some operators prefer to rupture the stricture within a few minutes at one sitting (Holt), while others occupy several hours for the process (Dittel). Oberländer and Kollmann advise doing the dilatation very gradually and at intervals of from ten to fourteen days.

The former claims the following advantages for his instrument: complete asepsis, easy and painless introduction, the ability to gauge accurately with the screw the amount of dilatation, and finally to stretch merely that part of the urethra which has been recognized

Fig. 289. Fig. 290.



Dilators with four arms. (Kollmann.)

by the endoscope as involved in the contraction. If care be exercised, there are no unpleasant after-effects experienced by the patient. A number of urologists suggest that the condition of the stricture and of the mucous membrane be observed with the urethroscope

during treatment by dilatation, and the further steps be governed entirely by what these examinations disclose.

At the present day cauterization of strictures has been abandoned by most operators. The method is based on the false assumption that the hindrance is due to granulations. For this purpose there have been employed silver nitrate, caustic potash, and other caustics, fixed on special holders. The galvanocautery has also been used. Englisch considers that the objections to this method are hemorrhage, ulcerations, and the liability to severe recurrences.

Opinions vary as to the certain value of electrolysis in removing strictures, although Newmann, who has attained great skill with this method, claims that in certain cases good results may be had. For the technic of the procedure the reader is referred to one of the special manuals on this subject.

The so-called bloody methods of treating stricture will now be considered. The object of these is the incision of the constriction, either from within or without. Internal urethrotomy is applicable to strictures in the straight portion of the urethra, in which dilatation has failed or has been rendered impossible by the presence of very firm cicatrices, or in cases in which it appears feasible to restore quickly the normal calibre of the urethra and shorten the period of treatment, and finally in cases in which the constriction consists of valves or bands. A preliminary requisite is the ability to introduce the cutting instrument through the stricture with or without the aid of a bougie as a guide. The method is not applicable in impermeable strictures, in complications with urinary infiltration, in the presence of abscesses and fistulas. Where the stricture is situated anteriorly, especially when there is a narrowing of the external meatus, an ordinary blunt-pointed bistoury may be employed; for those lying further back, specially devised urethrotomes are in use, of which there are many models. The instrument used is essentially a split canula, open at both ends, through which a mandril travels carrying the cutting edge. The constriction may be cut from before backward or in a reverse manner, by either an anterograde or retrograde urethrotome. The latter requires that the stricture be wide enough to permit the passage of that part of the instrument which carries the cutting edge. The introduction of the former type must be preceded by an exploratory bougie or the filiform prolongation with which some of these instruments are furnished. Figs. 291 and 292 illustrate the latest instruments of Fessenden-Otis and Kollmann. Thompson's instrument is shown in Fig. 293.

The operation may be performed under general anæsthesia or after cocainization of the urethra. The aim should be to cut through the entire thickness of the stricture, if possible through the upper wall, in order to lessen the danger of urinary infiltration. The instrument must then be withdrawn with the knife-blade covered. The after-treatment consists in the immediate introduction of a

retention-catheter, which insures evacuation of the urine and also serves by pressure to check the hemorrhage, which is oftentimes quite profuse.

If the asepsis is thoroughly carried out, the operation is practically free from danger. In 300 internal urethrotomies, Thompson observed urinary infiltration only twice, and abscess formation only once.

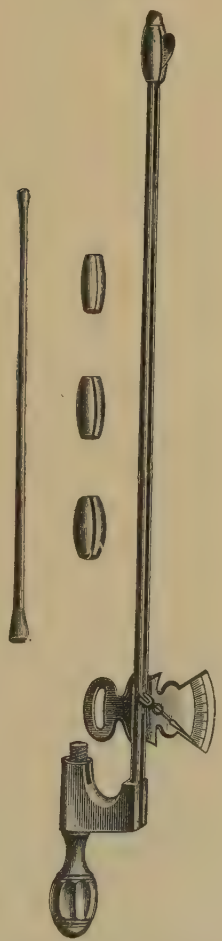
In order to maintain the result achieved, it is necessary to supplement the operation by prolonged treatment with bougies.

External urethrotomy, also known as the button-

Fig. 291.

Urethrotome combined with dilator. (Fessenden-Otis.)

Fig. 292.



Kollmann's urethrotome for doing internal urethrotomy under guidance of the eye.

Fig. 293.

Thompson's urethrotome.

hole operation or perineal section, is not only applicable to strictures, but also, as has been stated, to lacerations of the urethra, to the removal of foreign bodies and neoplasms, and in diseases of the bladder.

The indications for external urethrotomy in cases of stricture are as follows:

1. Elongated constrictions of the urethra, usually of traumatic origin, in which the cicatricial tissue is unyielding.

2. All strictures in which the previously mentioned methods of treatment have failed.

3. Strictures complicated by abscess and fistula formation, false passages, or a putrid vesical catarrh.

4. Completely impermeable strictures with retention of urine.

The author agrees with König in recommending opening the urethra in front of the stricture and division of the latter, for in this manner the vesical end of the urethra may be more readily found in the majority of cases. Search for the latter without this division of the stricture may often be unsuccessful, especially if the posterior section of the urethra is not distended by urine. In doing the operation the patient is placed in the lithotomy position, with the legs separated. The operator sits between the thighs and makes an incision into the perineum, along the median raphe, sufficiently long to extend beyond the limits of the stricture. The incision is carried down to the urethra guided by a catheter or bougie introduced into the latter. After opening the lumen of the canal the edges of the wound are seized with retractors and drawn asunder in order to expose the approach to the stricture. A fine probe is then passed through the stricture, the latter divided with this instrument as a guide, and a large catheter introduced into the bladder.

In many cases it is impossible to find the opening in the stricture or to pass a probe through it, especially if the cicatrix is to one side of the median line or if there are present fistulas, false passages, or diverticula. Very often by pressing on the bladder a quantity of urine may be forced out and the opening in the stricture revealed in this manner; or if the bladder is empty owing to the existence of urinary fistulas, pressure on the urethra through the rectum may cause a few drops of pus to appear and point the way. But even these manipulations may be unsuccessful when there is a marked distortion of the soft parts in the perineum from the formation of fistulas, when the vesical portion of the urethra is separated from the peripheral portion by a considerable amount of connective tissue (as in pelvic fractures), or when there is profuse hemorrhage. Hemorrhage is best controlled by compression, and only the larger vessels require ligation. In cases of this character Dittel in several instances has made an accessory incision through the sphincter ani, separated the rectum from the urethra, and in this manner isolated the proximal section of the

latter. In dense connective tissue this operation is, however, attended with a great deal of difficulty. The generally accepted procedure at the present time appears to be posterior catheterization through a suprapubic cystotomy opening, as recommended by Eigenbrodt, Trendelenburg, and Sonnenburg. Aspiration of the bladder can only be considered as a palliative measure. Brainard has suggested making a permanent fistula above the symphysis, through which posterior catheterization may be carried out. This procedure should at any rate be tried when there is a vesical fistula already present. When the vesical end of the urethra has been found, the urine, which is usually decomposed, should at once be evacuated from the bladder and a retention-catheter left in place, which may be passed out through the distal portion of the urethra. Some operators drain the bladder through the perineal wound; others, among them König, do away with the retention-catheter entirely, and restore the lumen of the canal by immediately instituting treatment with sounds. The retention-catheter is counter-indicated when the patient is very sensitive, when there is profuse urethral suppuration, and when there are ulceration and vesical hemorrhage. If a catheter is left in place, the bladder must be irrigated two or three times daily and its permeability frequently tested. In cases in which the urine is strongly alkaline the catheter itself must be changed every three days.

In selected cases the method of König, suggested in 1880, is to be recommended. In this the scar-tissue is excised and the ends of the resected urethra united by sutures in a manner similar to that practised in recent lacerations of the urethra. The traumatic, as well as some of the gonorrhœal, strictures are adapted to this method of treatment. König himself unites only the anterior wall with a few sutures, while others (Bramann, Mikulicz, Braun, Socin, Lauenstein, Guyon) have gone a step farther and closed the canal by means of a circular suture, and also the outer wound with the exception of an opening left for drainage. Bramann, after excising the cicatricial scar, first sutures the anterior and the lateral walls, and then introduces a retention-catheter, over which he sews the posterior wall with submucous sutures. The perineal wound is then closed in layers. The writer has obtained primary union in several cases, and in a few fistulas resulted, which lasted, however, only a short time and healed without special treatment.

A number of procedures have been suggested for those cases in which resection of the scar has left the ends of the urethra widely separated and their approximation by suture is impossible. Such a condition of affairs may follow severe trauma, suppuration, or gangrenous processes in the perineal portion. Gersuny successfully restored the canal in one case by taking two flaps of skin from the neighboring region, and in another by transplanting a flap from the thigh. Others have covered the defect with mucous membrane,

Meusel by transplanting the inner layer of the prepuce, and Wölfler by taking superfluous mucous membrane from a prolapsus uteri. The followers of Guyon long ago suggested the construction of a new canal from the soft parts of the perineum over a retention-catheter placed in the bladder. The regenerative powers of the urethra are quite remarkable, as has been demonstrated by casual autopsies (Francke) and by experiments conducted in dogs by Ingianni.

Finally those procedures require mention which entirely disregard the restoration of the missing portions of the urethra. Of especial interest is the procedure adopted by Mikulicz in one of his cases. The patient was a young man with a very extensive defect in both urethra and penis, with much scar-tissue, and numerous fistulas opening into the rectum. After cutting through the corpora cavernosa and the suspensory ligament, the penis together with the peripheral portion of the urethra was transplanted into the bladder, which had been previously exposed above the symphysis. In addition to this a trough was also gouged out on the upper border of the latter, into which the distal portion of the penis fitted. Poncet and Delore have recently revived the suggestion of Roser, which consists in making a permanent urinary fistula in the perineum whenever this can be done; the indications being recurrences, elongated strictures, pyelitis, cystitis, and advanced age. The objections to the method, however, are that the act of micturition can only be done in a sitting posture, and effective cohabitation is impossible because the semen is ejected at the perineal opening.

URETHRAL FISTULAS.

In rare instances urethral fistulas may be congenital as the result of persistence of the sinus urogenitalis. The aperture in these cases lies in the median raphe of the scrotum or the perineum. Dittel reports having seen it in 2 cases in connection with an imperforate anus. As a usual thing urethral fistulas follow traumatisms, such as incised, punctured, lacerated, and bullet-wounds, contusions, compression of the urethra, and gangrene from circular constriction of the organ. They also follow inflammations of the urethra and its vicinity, periurethral abscesses with gangrene, the pressure of a catheter, the incision of urethral diverticula, and finally they may result from perforation by new growths. According to their situation, it is possible to distinguish penile, perineal, and rectal fistulas. As the result of extensive urinary infiltration fistulas may be formed at comparatively distant points, such as the scrotum, the buttocks, and the inguinal folds. Where the external skin or the mucous membrane of the rectum is in direct continuity with the urethral mucosa the condition is known as a lip fistula. Such a fistula occurs on the inferior surface of the penis or in the rectum. If besides

urine the fistula also discharges pus, it is designated as a purulent fistula; if it is lined with scar-tissue, cicatricial fistula. Pus fistulas usually result from strictures; in consequence of ulcerative processes behind the constriction a urinary abscess is formed which breaks through the skin and leaves one or more sinuses remaining.

Diagnosis.—The diagnosis of these fistulas is simple when they open outwardly and discharge urine in considerable amount or drop by drop and mixed with pus. Although the appearance of urine may denote a communication with the urethra, exploration of sinuses with a probe, when they are irregular and tortuous, is often impossible even if a catheter is introduced into the urethra. For the purpose of tracing these fistulas, particularly if they empty into the rectum, it has been suggested to inject some inert colored fluid into the bladder, which on its discharge would serve to indicate the location of the sinuses. The patients complain of a burning pain in the fistulous tract during the act of urinating, and also of the inability to bring about conception because the semen is discharged through the abnormal opening. The differential diagnosis must be made from sinuses due to caries of the pelvic bones, rectal fistulas, and sinuses resulting from tuberculous processes in the prostate or Cowper's glands.

Prognosis.—The prognosis is in general favorable unless there are other complications present, such as cystitis. These fistulas rarely heal spontaneously and present marked difficulties in their operative treatment.

Treatment.—Suppurating fistulas require primarily removal of the cause, which is a stricture in the majority of cases. After the latter is dilated, the fistula often closes, as the disintegrating urine no longer comes into contact with it and the neighboring inflammatory reaction soon disappears.

When there are a number of branching sinuses, it is advisable to excise them, and also the stricture, carrying out practically an external urethrotomy.

Fistulous tracts which extend into the scrotum, the inguinal folds, or the thigh, should likewise be incised, curetted, and packed. When they are lined with epithelium and are surrounded by dense cicatricial tissue, the application of the silver nitrate stick may be tried, but in most cases it will be found necessary to excise completely the lining membrane down to the urethra. The resulting loss of substance may be covered in by a neighboring plastic skin-flap, after the edges of the wound have been trimmed and carefully approximated by sutures. Whether or not a retention-catheter should be introduced, is a matter of personal opinion. Dittel classifies the principal forms of plastic closure as follows: 1. Transposition of the adjoining segment of skin. 2. Freeing a bridge of skin from the subcutaneous tissue, and fixing it over the gap by suture. 3. Formation of a pediculated flap from the adjoining skin and transplanting it over

the defect. (Figs. 294 and 295.) In the case of a fistulous communication between the urethra and rectum, healing of the latter often follows division of the sphincter ani, because the feces no longer enter the sinus. If the fistula is lined with mucous membrane, the tract must be freshened after the sphincter is divided and then closed by suture. But even this procedure often results in failure. König has therefore suggested that the opening be closed by a pediculated flap of adjoining skin and healing secured in this

Fig. 294.

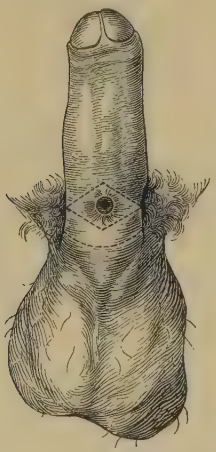
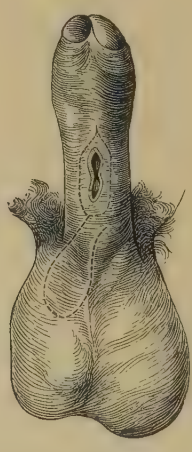


Fig. 295.



Plastic closure of a fistula of the penis. (Dittel.)

manner. Cooper frees the urethra from the rectum and by keeping both separated has succeeded in closing the sinus. Fuller proceeds in a similar fashion, but in addition to closing the sinus he twists the rectum through an arc of about 90 degrees and fixes it in this position. Preliminary to these operations the bowel must be thoroughly cleared out and irrigated, and after its completion a rectal tube should be inserted and defecation inhibited for six to ten days by the administration of opium.

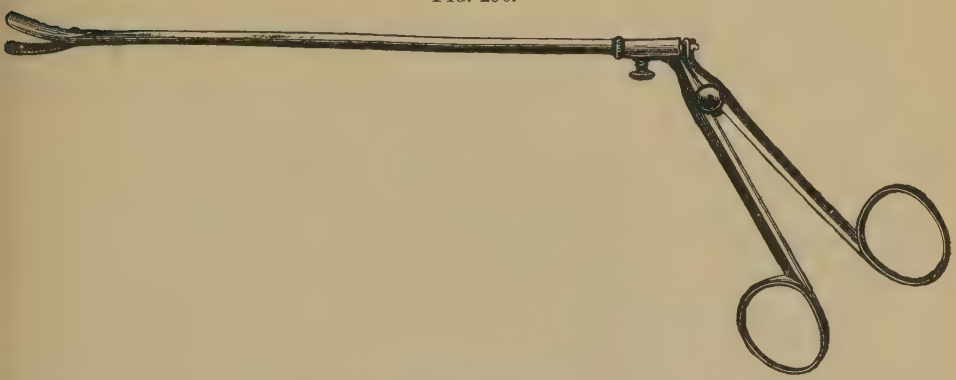
FOREIGN BODIES IN THE URETHRA.

In discussing this subject it is necessary to distinguish, in the first place, foreign bodies which enter the urethra from the bladder; secondly, those derived from external sources; and thirdly, those which are formed in the urethra itself—calculi deposited around a nucleus consisting of sediments or thickened secretions. Foreign bodies are introduced from without, usually to satisfy some erotic desire or by persons mentally defective, and include most frequently pins of all varieties, and less often bits of wood, twigs, roots, pipe-stems, fruit-pits, etc. Sometimes, catheters, bougies, or sounds intro-

duced for therapeutic purposes by the patient or physician may be broken and remain fixed in the urethra. Unskilful attempts at removal by the patient usually result in their being pushed farther back into the posterior urethra. The variations in the length of the penis in the absence of or during erection also have some influence in changing the position of the object, but it is not until the membranous portion is reached that muscular contractions begin to be effective and aid in forcing the foreign body into the bladder. It is in this manner that a not inconsiderable number of vesical calculi are formed—that is, by incrustation around some object, such as a pin, fruit-pit, or button which has reached that viscus through the urethral canal. Foreign bodies are therefore found in all parts of the urethra.

Symptoms.—Sharp, irregularly formed objects, such as pins, cause intense pain as soon as the point enters the mucous membrane. In other cases painful sensations are not noticed until there are advancing inflammation and irritation of the mucosa. Very often there is brought about partial or complete interference with urination by the obstructing foreign body itself, or the inflammatory swelling of the mucous membrane produced by its presence. When

FIG. 296.



Reiner's modification of Collin's extractor.

the object is not extracted at an early date or is forced out by the urinary stream, it may, if it is small and smooth, remain in the urethra, become incrusted, and then only very gradually lead to the production of symptoms. Pointed objects are apt to perforate the urethral walls by pressure and increasing inflammation, and remain in a pocket which communicates with the urethra, or they are spontaneously discharged by inducing a localized necrosis.

Diagnosis.—The diagnosis can be based on the history in only those cases in which a fragment of broken catheter or bougie has entered the urethra during instrumentation by patient or physician. Otherwise, particularly when the foreign body has been introduced

for masturbation, the history gives little or no authoritative information. The shape of the penis may give some information as to its actual presence by exhibiting a deformity at the site of the impacted foreign body. In the later stages fistulas and abscess formation must also be taken into consideration as affording a clew to the true state of affairs. To confirm the diagnosis, the organ should be carefully palpated in order not to dislocate the object, a rectal examination made when necessary, and the canal explored with a bougie. Goldberg reports in one instance having passed the bougie directly over the foreign body without touching it, and it seems advisable therefore not to exclude the presence of a foreign body simply because the examination by bougies has proved negative. In such cases recourse may be had to endoscopy, and finally to the Röntgen rays.

Prognosis.—The prognosis is favorable, especially if removal of the foreign body is accomplished at an early date. Otherwise there is always present the danger of the object entering the bladder. When the posterior portion of the urethra is invaded, gradual perforation, the formation of abscesses, and urinary infiltration are to be feared.

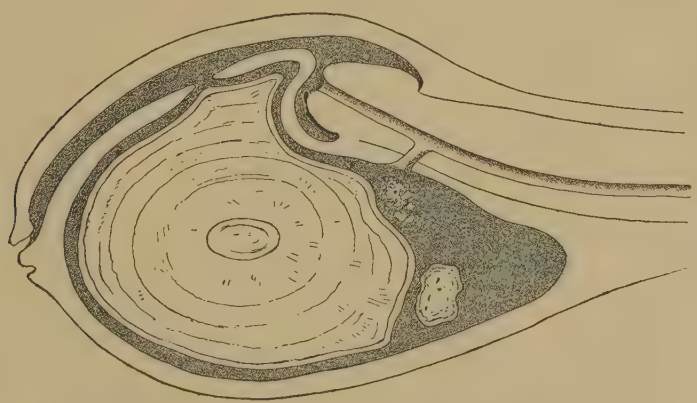
Treatment.—Foreign bodies must be removed by instruments introduced through the urethra; or if this method fails, through an external urethrotomy wound. Pins which have been introduced into the canal with their point directed toward the meatus, can be most readily extracted by forcing the point directly through the body of the penis and then turning them around so that the blunt end points forward. The extraction may then be completed by seizing the blunt end with a pair of the special forceps constructed by Collin, Mathieu, and others (Fig. 296), and withdrawing the object. Smooth objects resting in the pendulous portion may usually be removed in this manner, but for sharp-angled or impacted bodies urethrotomy is preferable. König advises making an extended incision in the skin and limiting that in the urethral wall as much as possible. In the removal of small objects the endoscope may also be used to advantage.

With the exception of the rare instances of bone fragments from an osteomyelitis, pelvic fracture, or bullet injuries, the foreign bodies which enter the urethra from the bladder are almost exclusively urinary concretions. The greater number of urethral calculi have therefore had their primary origin in the bladder. After the operation of lithotripsy as formerly practised, fragments from the crushed calculus were apt to remain embedded in the urethra. In children renal calculi may catch in the urethra. This rarely occurs in adults. It is an established fact, however, that concretions may arise in the urethra, *per se* after inflammations and injuries followed by suppuration, constrictions, and sinus formation, and, above all, from the incrustation around foreign bodies. The latter are always

phosphatic calculi, while those derived from the bladder or kidney may be composed of urates, oxalates, or cystin. Prolonged sojourn in the urethra causes the calculus to assume the form of the canal; at the junction of the bladder and the prostatic portion they are usually in the shape of an hour-glass or a mushroom. Sometimes stones are found in the urethra which are facetted in a manner similar to that observed in gall-stones. (Voillemnier.) Taking into consideration the size of the canal, enormously large stones have occasionally been observed. (Petit, Pulido.)

Urethral Calculi. — Calculi have been found in all parts of the urethra, but if a calculus is derived from the bladder, it is apt to get caught in the membranous portion, or if it passes through this, in the fossa navicularis, for these are the narrowest segments of the tube. When the calculi are large or are present in considerable numbers, they may remain embedded in the canal, the lumen of the latter dilating in direct proportion to the increase in the size of the stone. In other cases they are lodged in diverticula communicating with the urethra and formed by sacculations of the wall, or what is more frequent, by perforation due to pressure. Many of these pockets communicate with the surface by fistulas. Urethral concretions have been observed most often in children under ten years of age, and have even been seen in the newborn.

FIG. 297.



Large urethral calculus in a diverticulum shown in cross-section. (Kern.)

Symptoms.—The symptoms vary, depending on whether the stone has entered the urethra suddenly or has originated there by a process of gradual growth. In the former case there are present severe lancinating pains radiating toward the glans. There is also more or less interference with the passage of urine, and in children the latter is the most prominent symptom. The stones which originate in the urethra *per se* often do not cause any symptoms, and may sometimes be carried around for several years. The

patients become accustomed to their presence and overcome the interference with the urinary stream by manipulating the stone and moving it in various directions until the urine is passed and the bladder emptied. When inflammation of the mucosa takes place, together with ulceration of the urethral wall, the pain and urinary difficulties increase, the pus cannot be discharged, and as a result abscesses and fistulas are formed. Calculi resting in acquired or in congenital diverticula and pockets—a very rare condition—may likewise be the cause of little pain. In the anterior portion of the urethra astonishingly large concretions have been observed. (Fig. 297.)

Diagnosis.—The diagnosis is made from the symptoms just described, and may be confirmed by palpation of the penis, by examination per rectum, and the passage of sounds.

Prognosis.—The prognosis is good, and can only be unfavorably affected by the occurrence of suppuration or urinary infiltration. Heimann describes a case seen by him in the Strassburg clinic, of impacted stone in a boy two and a half years old, in which urinary infiltration extended from the umbilicus to the knee. The child was saved by the operation.

Treatment.—Small stones in the anterior portion of the urethra may be removed by means of a clamp or a urethral forceps. Often it is necessary to enlarge the external meatus, and then the calculus may be liberated with a sharp spoon. When this is not successful, an incision must be made over the stone and the urethra opened.

CHAPTER XXIX.

DISEASES OF THE URETHRA EXCLUSIVE OF VENEREAL DISEASES.

TUBERCULOSIS OF THE URETHRA.

Acute and chronic inflammations of the urethra are usually dependent on venereal infection. In a book of this character, which is devoted exclusively to the subject of surgery, consideration can only be given to surgical complications, such as constrictions, fistulas, and defects of the urethra. These are discussed in the preceding chapter.

Tuberculosis of the urethra is extremely rare, and is always combined with tubercular disease of the urogenital apparatus or with a generalized tubercular process. In the cases reported it has been confined to the membranous and prostatic portions of the urethra, and only in isolated instances to the anterior segments. Pathological lesions comprise the formation of tubercles, ulceration, and cheesy degeneration, similar to what is found in other tubercular organs. In the majority of cases urethral tuberculosis develops as a secondary process either descending from the kidneys or ascending from the testicles through the medium of the prostate and the seminal vesicles.

Primary tuberculosis of the urethra has undoubtedly been observed, being probably brought on by infection during sexual intercourse or through the medium of the circulation. (Kraske.) Baumgarten experimentally produced in guinea-pigs a typical tuberculosis of the urethra by a single injection of a culture of tubercle bacilli into a normal and uninjured canal. Englisch has made a number of observations in regard to tuberculous urethritis and periurethritis in the region of the prostate and the seminal vesicles. It occurred invariably in tubercular individuals who at first presented a chronic purulent discharge which proved resistant to all treatment. Later there appeared redness and swelling in the perineum in the region of the bulbous urethra. The swelling then broke down and was followed by the typical undermined ulcers and fistulas, with flabby granulations. Judging from the manner and the extension of the inflammation, tuberculous periurethritis probably takes its origin in most cases from a primary tuberculosis of Cowper's glands. Localization of the tuberculous process in the urethra may in exceptional instances lead to the appearance of signs of stenosis. Ahrens has reported a case of this kind in which a cheesy infiltration of the

mucous membrane in the posterior portion of the urethra produced a typical stricture which caused urinary retention.

Treatment.—Treatment is successful for a short time only, and is only applicable in the primary cases. It consists of thorough curettage of the fistulous tracts and ulcers and all other tuberculous foci within reach. In case the disease is present in connection with tuberculosis of other organs, it must be taken as an indication of a severe general infection, and demands merely palliative treatment.

TUMORS OF THE URETHRA.

Benign Tumors.—Papillomata and polyps are found in the urethra. The former are due to a proliferation of cells from the papillary layer in localities that are devoid of epithelium as the result of a gonorrhœa or some other catarrhal condition, and have the same structure as the pointed condylomata found on the prepuce. They may occur singly in various parts of the urethra or in berry-like groups. The latter may cause a slight discharge and sometimes urinary retention, but the smaller varieties usually are present without symptoms. In this condition endoscopy is a valuable aid to the diagnosis, as a sound or a bougie may be readily passed over the growth without meeting resistance. Whether they disappear spontaneously or are removed by operative procedures, there usually is left behind a dense infiltrated scar which may lead to the formation of a stricture, or a recurrence may occur. The tumors may be removed by the galvanocautery, or, what is preferable, they may be eradicated by Oberländer's method, as follows: Two applicators covered with cotton are introduced side by side into the urethra and through the masses which are to be removed. The penis is then tightly seized and the tampons are moved backward and forward, loosening the growths and tearing them away from their attachments.

Urethral polyps, of which there are only isolated reports, are fibrous and pedunculated, and have all been observed in the region of the seminal vesicles. For their removal the polyp-snare of Grünfeld is recommended.

Malignant Tumors.—Of greater importance is carcinoma of the urethra, which in this locality is usually secondary to that disease in the prostate, the bladder, or the corpus cavernosum. As a primary growth it is of rare occurrence, although an increasing number of clinical cases are being reported. The neoplasm has been observed in the perineal portion more often than in the cavernous portion of the urethra. It is derived from the epithelium of the mucosa or its glands. Ulceration comes on rapidly, destroys the urethra, involves the penis, and goes on to the formation of a fistula. The sufferers from this affliction are usually old men—of an age at which carcinoma prevails. In almost every case there has been an inflammation of the urethra, succeeded

by stricture or the formation of a fistula, so that these conditions may be properly considered as predisposing to the growth of urethral cancer. The symptoms closely resemble those of a stricture which has been followed by infiltration of the periurethral tissue and sinus formation, and in only in a few cases has an early diagnosis been made. This was rendered possible with the assistance of the urethroscope and the examination of bits of the growth which could be scraped away. The possibility of completely eradicating the growth depends entirely on making such an early diagnosis, and Rupprecht reports having successfully removed a cancer of the urethra, after the latter had been recognized by endoscopic examination, which involved about 4.5 cm. (1.8 inches) of the bulbous portion and necessitated resecting 8.5 cm. (3.4 inches) of the urethra. The penis in this case did not have to be sacrificed. If an old quiescent stricture of the urethra begins to constrict rapidly, and bleeds readily even with careful sounding, when there is at the same time a distinctly increasing hardness around the bulb in the perineum, an examination with the urethroscope should be made at once. The diagnosis may be obscured for a time by inflammatory œdema in the perineal region, brought on by the passage of sounds. Such swellings may disappear or lead to abscess formation. Endoscopy and microscopical examination of bits of the tumor-tissue will at once clear up the diagnosis.

Aside from a case in the early stages of growth, such as the one just described, and a stricture, the only other condition which needs to be differentiated, is a carcinoma of Cowper's glands. The latter is extremely rare, as only five instances have been reported. In the later stages both varieties extend over and involve the perineum, prostate, and penis, and can then no longer be differentiated microscopically. Kaufmann claims that carcinoma of the urethra in its early stages produces symptoms of constriction, can be palpated at the bulb, interferes with catheterization, and may be recognized on endoscopic examination. A carcinoma of Cowper's glands also causes interference with urination, but its symptoms are aroused rather by the act of sitting, walking, or defecating. The tumor can be felt behind the bulb, at the anus, and under the prostate; it does not interfere with the passage of the catheter and cannot be recognized on endoscopic examination.

Treatment.—The treatment consists in extirpation of the neoplasm. In those cases in which the growth is restricted to the urethra alone the diseased sections may be resected without mutilating the penis. In Rupprecht's case no recurrence took place for over four years. In advanced cases it is necessary to extirpate the penis completely together with the infiltrated inguinal glands, but the prognosis is doubtful even after this radical measure.

DISEASES OF COWPER'S GLANDS.

The so-called Cowper's glands are a pair of structures, each as large as a pea, which lie beneath the membranous portion of the urethra, close behind the opening in the pelvic fascia. Their clear, tenacious secretions are poured out through the excretory ducts, which form a single canal, the latter emptying into the urethra near the bulb. An acute inflammation of these glands, Cowperitis, is frequently found as a sequel to gonorrhœa or to retrostrictural inflammations. This affection is probably overlooked in most cases, especially if the entire perineum is infiltrated. When an inflammatory process is restricted to these glands, it should be possible to feel a small olive-shaped, painful nodule immediately back of the scrotum and on each side of the median line. Under normal conditions the glands are not palpable. Suppuration may occur and perforation take place into the urethra, rectum, or perineum. In many cases obstinate fistulous tracts may remain.

Diagnosis.—The diagnosis can only be made when the inflamed glands can be individually palpated, and this is impossible when the perineum is infiltrated.

Treatment.—The treatment consists in incision, and if there are sinuses present, the latter, together with the remnants of the glands, must be extirpated. A tubercular inflammation of these glands, in contrast to acute Cowperitis, develops unawares in persons otherwise afflicted with tuberculosis, and secondarily extends to the urethra and the periurethral tissues. Among the tumors found in Cowper's glands are cystic growths and carcinoma. The former are supposed to occur particularly in children, and may cause urinary retention. Carcinoma has been reported as a primary condition in only five instances. The differential diagnosis from primary urethral carcinoma was discussed in the preceding chapter, and this is the only condition with which it may be confounded. When an early diagnosis is made, extirpation of the glands affords a favorable prognosis.

MALFORMATIONS, INJURIES, AND DISEASES OF THE PENIS.

CHAPTER XXX.

CONGENITAL ANOMALIES OF THE PENIS.

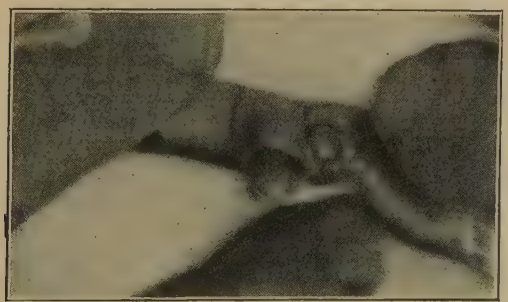
TOTAL AND PARTIAL ABSENCE, DOUBLE PENIS, AND DIVIDED PENIS.

COMPLETE absence of the penis has been noted in only four instances, a rudimentary development in three. In all these the

FIG. 298.

Double penis combined with exstrophy of the bladder, showing also four urethral orifices. (Carl Beck.)

FIG. 299.

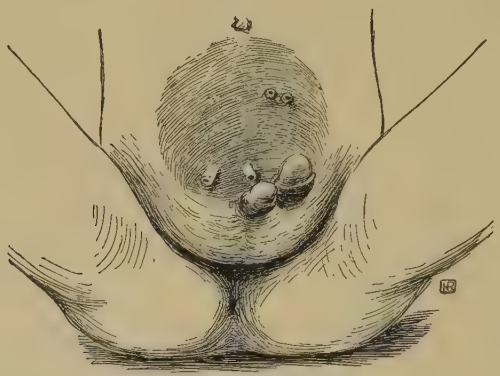


A nearer view of Fig. 298. (Carl Beck.)

urethra was also imperfectly developed, and in the former group it emptied into the rectum. In the cases in which a rudimentary

penis was present, the organ was hidden under the skin of the scrotum or the pubic region. But very few instances of double penis have been reported. (Figs. 298–300.) In three of these, the two

Fig. 300.



Drawing made of the condition shown in Figs. 298 and 299.

Fig. 301.

Congenital cleft of the penis in hypospadias. (After Englisch.)

organs lay close together, the urethras became united in the region of the symphysis and emptied into a common bladder. In two

others the two organs were widely separated, and there were two bladders which communicated. The urethra of only one penis discharged urine. The testicles rested in two distinct and separate scrotal sacs

The changes in form which are found associated with epispadias and hypospadias have been discussed in Chapter XXVII. Mention should be made, however, of the exceedingly rare congenital condition described as a longitudinal division of the penis, shown in Fig. 301. The only case of transverse division of the penis is that reported by Hofmokl.

CONGENITAL PHIMOSIS.

Phimosis is the term applied to a congenital condition in which the prepuce is constricted to such an extent that it cannot be drawn back over the glans even when force is employed.

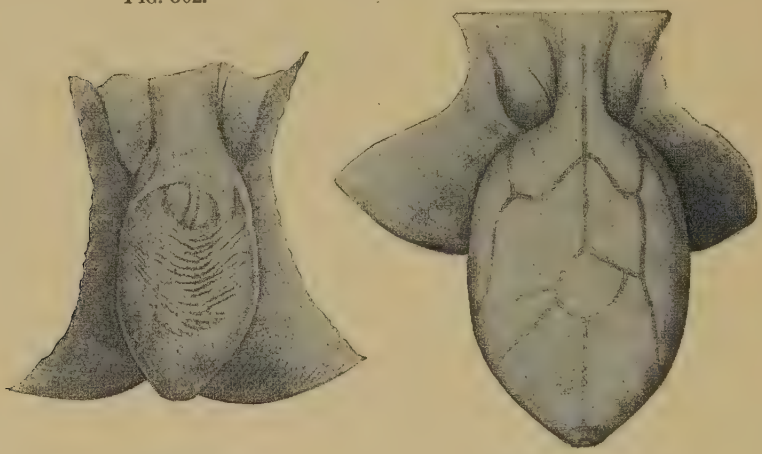
A moderate degree of adhesion is present as a physiological condition in all newborn infants. The inner layer of the prepuce is found adherent to the glans, which causes retention of the white masses made up of glandular secretions and epithelium. These adhesions disappear spontaneously at some time from the first to the thirteenth year of life, unless it has been found necessary to break them up by gentle force. In many cases, however, the preputial ring does not dilate—usually as the result of inflammations and cicatricial contractions, and the glans cannot emerge through the opening. Very often the prepuce is elongated and thickened, and then we have the condition known as hypertrophic phimosis; in others it is thinned, resulting in an atrophic phimosis. In phimosis of long standing there may be very firm adhesions and the inner layer of the prepuce and the glans may grow firmly together.

Symptoms.—During childhood the most frequent symptom caused by phimosis is difficulty in urinating. By constant pressure the urine is voided in a thin stream; but if any inflammatory process supervenes at the prepuce, total retention of urine may result. If the prepuce in addition is hypertrophied, it may become dilated by the accumulating urine, which then constantly drips from the opening. The dilated sac may become as large as a hen's egg. (Figs. 302 and 303.) The retained urine may stagnate, become ammoniacal, and cause ulceration and even perforation of the prepuce. At other times there is a deposit of calcium salts which results in the formation of the so-called preputial calculi, occasionally found of marked dimensions and in considerable number.

The interference with micturition causes these children to bear down constantly when urinating, and the straining efforts probably result in the development of umbilical and inguinal hernias, as well as prolapse of the rectum. The frequency of these asso-

ciated conditions seems to afford proof of their origin, but this theory is energetically combated by others, among them Englisch. The hydrocele of the tunica vaginalis so often seen in children is also considered to be due to this condition. Karewski has stated that Jewish children, who are all circumcised, are never

Fig. 302. Fig. 303.



Empty. Distended.

Sac-like dilatation of the prepuce. (Steckmetz.)

afflicted with a hydrocele, and, moreover, that this effusion soon disappears in children with a phimotic prepuce when the latter is removed. Some believe that the hydrocele is due to pressure on the vasa deferentia from constant straining efforts during urination ; and again others, that it is due to inflammatory changes, eczema, etc., of the prepuce which accompany the phimotic condition of the latter.

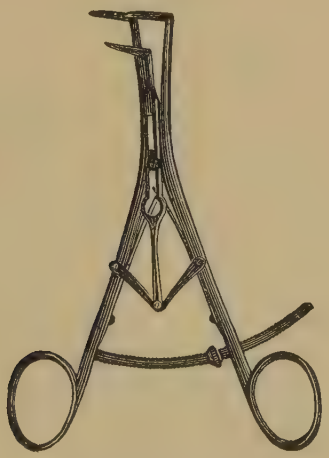
Children with phimosis are subject to nocturnal incontinence, and it is believed that the erections caused lead many of them to practise masturbation. In older boys and men afflicted with phimosis Panzat has observed urinary difficulties associated with severer complications, such as cystitis and pyelitis. In adults disturbances of the sexual function are also often observed.

From what has been stated, it is evident that congenital phimosis is a condition which bears careful watching. Operative procedures which tend to restore the normal relations are always attended with a favorable prognosis.

Treatment.—Prophylactic measures are of great importance, for there are a large number of children afflicted with umbilical and inguinal hernias, hydrocele, difficulty in urination, and inflammatory conditions of the prepuce, in whom the cause may be traced to a phimosis, which is possibly only physiological in degree. As a rule

the adhesions may be readily broken up with the aid of a small probe and the foreskin retracted back of the glans with the loss of only a few drops of blood. (Fig. 304.) The child is seen every week for a time, and the parents are directed to pull back the foreskin daily and apply a cooling lotion (2 per cent. aluminum acetate, or boric acid solution). Under this treatment the phimosis and the attending complications almost invariably disappear. Even in older boys, up to the fourth year, when the condition has become more confirmed, this method of forcible retraction often suffices, if the glans can be used as a wedge to dilate the preputial orifice. All cases which do not respond to these simple measures must be subjected to operative procedures.

FIG. 304.

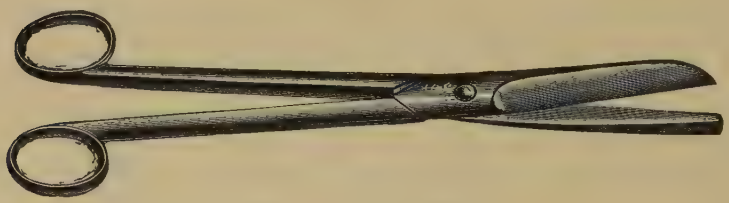


Nélaton's prepuce dilator.

Many methods have been devised for this purpose. The simplest, and that particularly adapted for a prepuce which is not hypertrophied, is the dorsal incision. In favorable cases this may be performed under cocaine. After a thorough cleansing of the penis and the surrounding parts a grooved director is introduced between the glans and the inner layer of the prepuce to the sulcus, care being taken that the instrument does not enter the urethra. The blade of a straight, blunt-pointed scissors is then introduced along the groove of the director and the foreskin is divided with one cut as far back as the sulcus. (Fig. 305.) The edges of the wound gape and expose the glans, and the accumulated smegma may be removed. The inner layer of the prepuce is usually not divided as far back as the outer, and may be incised so as to form a small triangle with its base at the sulcus, about 0.5–2 cm. (0.2–0.8 inch) in length. The point of the latter is then united to the angle in the outer layer and the edges of the wound in both layers are approximated by suture. Any slight irregularities of the edges may be trimmed away with scissors. The advantage

of the small triangular flap consists in avoiding a cicatricial contraction of the wound in the outer layer, by substituting for this a covering of mucous membrane. The larger bleeding points must be carefully caught and ligated in order to avoid the formation of a hæmatoma in the loose connective tissue. This method is usually sufficient in

Fig. 305.



Taylor's phimosis scissors.

most cases. When the prepuce is more tightly adherent to the glans, however, the director can be introduced only a short distance or not at all, and then it becomes necessary to divide the skin from the glans forward and forcibly separate the adhesions. In some cases the latter are very dense, and like connective tissue, so that they can only be divided with the knife and with considerable bleeding. In order to prevent the two wounded surfaces from again becoming adherent, it is essential to keep them separated by strips of gauze or to cover them with transplanted flaps. When the prepuce is hypertrophied, the redundant foreskin should be removed, for which several methods have been devised.

The dressing after an operation should consist of a few strips of gauze loosely wound around the organ, and as soon as these are saturated with blood, applications of a weak antiseptic solution may be made. In five to eight days the edges of the wound unite and the sutures can be removed.

Circumcision is also carried out as part of a religious ritual, but it is often done incompletely and without proper precautions as to cleanliness. Although numerous cases have been published in which death resulted from hemorrhage, or in which infection by syphilis or tuberculosis occurred, the operation is still performed without legal restraint.

In conclusion there should be mentioned the congenital shortening of the frenum which occurs with an otherwise normal prepuce. This condition interferes with the complete retraction of the foreskin and causes various annoying symptoms, which are usually evident during coitus. It is recommended that the band be incised deeply in a transverse direction, sufficient to permit of the easy retraction of the prepuce and the wound sewed in the longitudinal axis of the organ.

CHAPTER XXXI.

INJURIES OF THE PENIS.

SUBCUTANEOUS INJURIES OF THE PENIS.

A SUBCUTANEOUS laceration of the corpora cavernosa can only occur during a state of erection of the penis, and is ordinarily designated as a fracture.

Fracture is a term less applicable to man than to some of the lower animals, such as the dog and the bull, that normally possess an os penis. In rare instances, however, pathological deposits of bone or cartilage have been observed in old men, in the form of thin plates in the septum of the penis or in the sheaths of the corpora cavernosa. In consequence of this there may result a curvature of the penis because the sheaths of the corpora cannot be stretched at the site of the deposits. The treatment consists in excision of the bony plates.

Fracture of the penis results from incautious movements during coitus, or by striking the penis while in a state of erection against some hard object, or by twisting or bending the penis. Laceration of the corpora cavernosa is explained by the fact that their sheath is reduced from a thickness of over 2 mm. ($\frac{1}{12}$ inch) during the flaccid condition of the penis to about 0.25 mm. ($\frac{1}{100}$ inch) during the state of erection. The cavernous tissue is, moreover, incapable of withstanding much resistance. A transverse laceration of the tunica usually results, which extends into the substance of the corpus to a greater or less degree. The blood contained in the latter forms an extensive hæmatoma under the uninjured skin and the penis is enlarged to twice or three times its normal size. Its erectile condition disappears at once and the organ remains completely flaccid. Patients have declared that at the time of the injury they were cognizant of a distinct cracking sensation. The fracture may take place at any point in the pendulous portion, directly behind the glans in the middle or in front of the symphysis. The further course of the trouble depends entirely on whether or not the urethra has remained intact. If this structure has not been involved, the hæmatoma resolves quite rapidly, and a complete cure results with the power of erectility restored. In some cases, however, a dense cicatrix may be formed in the corpus cavernosum, which interferes with erection or else causes a curvature of the penis. Then again the hæmatoma may not resolve, and will then require treatment at a subsequent time. When the urethra is also involved, the situation

becomes very much more complicated. In 18 cases collected from literature by the authors this condition was present in 10, and in several of these there was a complete laceration of the canal. Soon after the injury has been inflicted blood appears at the meatus, followed after a longer or shorter interval, depending on the degree of laceration, by retention of urine and its consequences—infiltration, suppuration, and extensive gangrene of the skin. The diagnosis can be readily made from the history and from what has just been detailed. At the site of the tear pain may be elicited on pressure, and sometimes a hiatus can be made out in the corpus and its sheath. This together with retention and the appearance of blood at the meatus should make the diagnosis evident.

The prognosis is in general very good, if the urethra has not been involved. The formation of scar-tissue may, however, interfere with the power of erection to such an extent that there results either a sharp bend in the penis or the organ remains flaccid on the distal side of the cicatrix, so that in any case coitus becomes impossible.

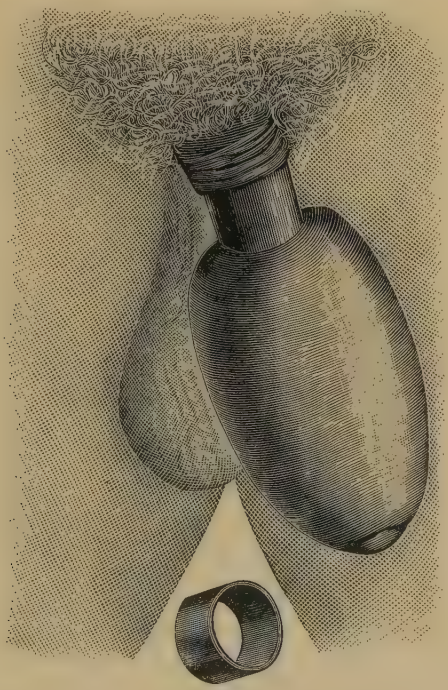
When there is a simultaneous laceration of the urethra, everything depends on rational treatment, which must be instituted as early as possible. If a catheter can be introduced, it may be possible to prevent the urine from coming into contact with the wound. In addition, the organ should be kept in an elevated position and compresses and cold applications applied. If catheterization cannot be accomplished, an external urethrotomy may be performed with or without immediate suture of the ends of the divided urethra. Infiltration of urine and suppuration require free incisions. If hæmatoma is present for a considerable time and does not resolve, it may be aspirated and then subjected to compression, or it may be removed by an incision followed by suture.

Crushing injuries of the skin of the penis and of the corpora cavernosa while the organ is in a state of relaxation may be due to direct force, to blows, to falls, and to being run over. In the latter case the penis is crushed against the symphysis upon which it may happen to rest. The consequences in mild cases are ecchymosis and induration of the skin and swelling of the penis. Usually the urethra is also involved, and then the principal symptoms are those of the urethral injury, which have been described in a preceding chapter.

Constrictions of the penis by various foreign bodies are occasionally observed. During play boys have been known to tie strings, hair, or tape around the penis, and ignorant nurses have been known to wind a string around the organ in order to prevent nocturnal incontinence. Adults employ rings and a great variety of other objects for the purposes of masturbation. These things are usually applied during the relaxed condition of the organ. The penis then swells and cords and thin rings disappear very soon in the œdematous tissues. The greatest enlargement takes place in the

peripheral end, which also assumes a pale color. (Fig. 306.) If the constriction is not relieved, the object may cut through the skin, which heals, and then the foreign body may entirely disappear and not produce any further symptoms for a long period.

Fig. 306.



Showing the effects of a constricting metal band on the penis. (Wasiliew.)

Very often the constricting object compresses the urethra and causes urinary retention. This may finally result in gangrene of the urethra and the formation of a fistulous opening on the lower side of the penis. When the foreign body is quite large a partial gangrene of the peripheral portion of the organ may result.

The diagnosis is simple in the case of the larger foreign bodies, but is quite difficult when a thin ring or a string has been buried for a considerable period, for the true facts of the case are seldom volunteered by the patient. A careful examination (supplemented by an *x*-ray examination) and the presence, perhaps, of a fistula usually serve to indicate the right diagnosis.

The treatment consists essentially in the removal as soon as possible of the offending bodies—hairs and threads with forceps and scissors, and rings, etc., with a cutting-pliers or a file.

Poncet reports an instance in which a man drew his penis through the opening in a heavy steel hammer, which brought on

retention of urine and gangrene. It was found impossible to break up the hammer, so that the author was compelled to incise freely the peripheral extremity, and then by compression to reduce the size of the organ sufficiently to permit the removal of the object. Complete recovery resulted.

WOUNDS OF THE PENIS.

Incised Wounds.—Wounds of the penis made by a sharp instrument are in rare instances accidentally inflicted by a pocket-knife, or a bit of glass, or in a ritual circumcision. In the majority of cases, however, they are inflicted with the intention of mutilating by the mentally defective, or are done with criminal intent by vindictive women during coitus. These wounds may be either transverse or longitudinal, with more or less complete amputation of the organ and involvement of the urethra. The bleeding is especially severe if the penis is in a state of erection at the time of the injury, but a fatal hemorrhage has rarely been observed. Boyer and Nélaton have stated that gangrene followed a wound which extended through two-thirds of the thickness of the corpus cavernosum, but Vedrenne reports having seen healing take place after complete division of both corpora cavernosa, only the urethra with its corpus spongiosum having remained intact. The treatment consists in stopping all hemorrhage, exact suture, and complete rest of the parts—all under aseptic precautions. If the urethra has been injured, a retention catheter should be inserted. When a section of the penis has been amputated, care must be taken that no narrowing takes place at the urethral opening. For this purpose the mucous membrane of the urethra may be sutured to the outer skin, by dividing the inferior wall of the canal if necessary.

The so-called emasculation is carried out at the present day by the Abyssinians, and in the last war against the Italians they practised it on their prisoners. By means of a sharp sword they completely amputate the external genitals. A certain sect in Russia, the Skoptzy, also carry out this procedure, and in the Orient it is done for the purpose of securing eunuchs.

Punctured Wounds.—The protected situation of the penis affords few opportunities for the infliction of punctured wounds. They are usually caused by the point of an opened pocket-knife or by bone fragments from fractures of the pelvis. Treatment is similar to that for incised wounds. Lacerated wounds are more common, especially the tearing of the frenum during coitus. This small wound becomes readily inflamed, and if suppuration takes place, the picture closely resembles an ulcerating chancre. More extensive lacerated wounds also occur, accompanied by partial or complete ablation of the skin of the penis.

Dislocation.—When the prepuce has been torn away, the penis

may readily slip back under the skin and remain fixed there, producing what is described as a dislocation. According to Kaufmann, these injuries commonly result from the trousers of the individual catching in moving belts, machinery, or wagon-wheels, so that they are torn away from the body together with the genitals. The bite of a horse or dog may also produce a similar injury, and in these cases the testicles and scrotum are almost always involved. In a luxation of the penis the organ is retracted toward the scrotum or the symphysis, and may remain in this locality. Palpation then reveals a short, relaxed, often irregular sac of skin, which may be rendered somewhat tense by the infiltration of blood, but is incapable of erection. The urine collects under the skin and dribbles away from the opening in the sac, and in addition, urinary infiltration may follow with its attendant train of symptoms and serious consequences. In many cases the penis may be detected as an elongated body under the skin of the scrotum or the abdominal wall in the region of the symphysis. In advanced cases the displaced organ may grow fast *in situ* and render the diagnosis and treatment a more difficult matter. When a catheter is inserted, it does not enter the bladder, and this point may be of value in confirming the diagnosis.

In recent cases in which the organ can be felt under the skin, the latter may be incised and the penis replaced in its proper dermal covering. Nélaton's suggestion, to seize the organ with a forceps introduced through the skin of the penis, is probably only of value in very recent cases. The penis is fixed to the skin by sutures, and if no complications set in, healing usually takes place promptly. In old cases the skin of the penis may be so contracted that it proves insufficient to cover the replaced organ. Plastic operations are required in this as well as in cases in which the skin of the penis, with parts of that from the scrotum and the pubic regions, has been destroyed to a greater or less extent by the injury itself or by cellulitis, erysipelas, or gangrene. Even without these remedial measures, healing usually takes place, but it is accompanied by extensive cicatrization and deformity in the direction of the symphysis, so that coitus is interfered with and even prevented by the pain of erections.

If the prepuce alone is missing, its place may be taken by a section of skin drawn forward from the body of the penis. When the skin of the latter is also destroyed, the loss must be supplied by flaps taken from the neighboring regions, preferably the scrotum. Küster, Körte, Wagner, Reich, and others, have successfully employed flaps with a double pedicle, which bridged the defect, while Bessel-Hagen used a single-pedicled flap from the scrotum. Kappeler and Pilz have advantageously used the prepuce when this was uninjured, to diminish the size of the defect on the body of the penis. It is a much more difficult matter to cover the penis when the skin of the scrotum is lost or is so cicatrized as to be unfit for plastic purposes.

As Bessel-Hagen has shown in a case in which the entire covering of the organ was lost, the skin from the lower portion of the abdomen may be advantageously used to supply the defect.

Bullet-wounds.—Bullet-wounds of the penis are usually only seen during war, and are then combined as a rule with severe injuries of other parts—scrotum, testicles, thigh, and particularly the pelvis. Beck saw 24 cases among 4344 wounded soldiers. They rarely occur without injuries to the urethra, but may simply perforate the glans or the corpus cavernosa, or lacerate the skin. In treatment the possibility of an injury of the urethra must be borne in mind, which may have been pierced in a number of places. A retention-catheter should be introduced into the bladder, the wound trimmed and cleaned, and if extensively lacerated, the parts may be united by suture. If the perineal portion is involved in the laceration by the projectile, urethrotomy and the retention-catheter are indicated. If there is urinary infiltration or suppuration, it is essential to make free incisions and provide efficient drainage. The prognosis is good in uncomplicated cases. If the urethra is involved, or if there are accompanying lesions in the bones and soft parts, it is quite doubtful. Kaufmann has collected 119 cases with involvement of the urethra, in which the mortality was 26, or 22 per cent.

CHAPTER XXXII.

DISEASES OF THE PENIS, EXCLUSIVE OF VENEREAL DISEASES.

INFLAMMATIONS OF THE PENIS.

Balanoposthitis.—Acute inflammations of the surface of the glans, or balanitis, and those of the prepuce, posthitis, are almost always seen together, and the term balanoposthitis has therefore been applied to this condition.

The rather frequently occurring catarrhal balanoposthitis is due to lack of cleanliness, to decomposition of accumulated smegma in a phimotic prepuce, or to mechanical irritation from coitus or masturbation. It also occurs as a complication of specific infection, particularly gonorrhœa and hard or soft chancre.

FIG. 307.

Gangrene of prepuce with buttonhole-like opening over glans. (Taylor.)

Symptoms.—The symptoms comprise redness and swelling of the glans and the inner layer of the prepuce, and from the œdematous and contracted foreskin there is often discharged a thin foul-smelling pus. The patient complains of the constant irritation and more or less burning pain. In neglected cases ulceration is apt to occur on both the glans and the foreskin, with possible perforation. (Fig.

307.) Very often children and occasionally adults may present a complicating lymphangitis of the penis and an inguinal adenitis.

Treatment.—The treatment if congenital phimosis is at hand, consists in operative cure of this deformity. (See page 629.) Otherwise frequent washing with soap and water, followed by mild antiseptics and the application of dusting powders, is indicated, preferably bismuth or zinc oxide. If gonorrhœa or chancre is the cause, specific measures must be instituted, the discussion of which is out of place in this connection. A balanoposthitis with a croupous membrane has been observed in rare cases after ritualistic circumcision (Bokai); but the membrane was not adherent and healing rapidly took place under the application of antiseptic dressings. True diphtheritic membranes on the glans and prepuce have also been seen in connection with pharyngeal diphtheria. In conclusion, mention should be made of a type of inflammation of the glans and prepuce found in diabetic individuals, which resembles the catarrhal processes in every way, except that ulceration is more liable to occur. If a phimosis is present, the proper operation should be done; otherwise the treatment consists in antiseptic applications and daily cleansing.

Acquired Phimosis.—As the result of these preputial inflammations with œdematous swelling and contraction of the foreskin, there may occur the condition known as inflammatory or acquired phimosis. The cause may be referred to the irritations and specific infections already mentioned, or to erysipelatous and phlegmonous processes. In addition, a phimosis may also be due to cicatricial contractions following a healed chancre or other inflammatory process, or an injury. Chronic œdematous swellings of the skin and connective tissue, which are often associated with diseases characterized by generalized congestion, such as nephritis, endocarditis, hepatic cirrhosis, etc., may cause an œdema of the penis and the foreskin and a contraction of the opening in the latter. The form of the organ in these very chronic cases is quite characteristic.

Symptoms.—In the case of an inflammatory phimosis there is often a purulent discharge from the opening, the foreskin itself is red and swollen, the free passage of the urine may be interfered with, and the patients complain of a burning pain or an intense localized itching. The diagnosis is readily made, especially when a phimosis is present; but the exciting cause, such as an ulceration on the glans or prepuce, can sometimes not be determined until the foreskin has been incised and the underlying regions exposed.

In neglected cases perforation and partial gangrene may result.

Treatment.—For the cure of these conditions operative measures are essential. Local syringing and irrigations with antiseptic solutions rarely effect a permanent cure. The simple incision is usually sufficient, for this exposes the inflamed area and whatever ulcers may be present, and affords adequate drainage for the retained secretions.

Specific ulcers and induration are best gotten rid of by a complete circumcision—and infection of the wound by chancrous processes need no longer be feared since the introduction of modern antiseptic methods. Contractile scars should also be excised, the resulting defect being covered, if necessary, by plastic flaps. In cases in which there is an œdema due to chronic congestion the treatment is limited to elevation of the penis and attempts at reducing the swelling by compression.

Paraphimosis.—A frequent complication of both the congenital and the acquired forms of phimosis is a paraphimosis. (Fig. 308.) The presence of a certain degree of phimosis is essential for the production of this condition, which is caused by the

Fig. 308.

Paraphimosis: penis curved at nearly a right angle. (Taylor.)

forcible retraction of the foreskin behind the glans and an inability to return it to the normal location. Children are very apt to push the glans through the narrow opening in the foreskin during play or for the purpose of masturbation. In adults the condition is usually brought on in coitus. When the contracted opening in the prepuce slips over the glans and rests in the coronal sulcus, reduction can still be accomplished if attempted at once, otherwise in a very short time the constricting foreskin causes a congestion and swelling of the glans, so that it cannot be replaced without considerable pain and the application of some force. Two circular ridges are formed back of the corona; the anterior one is smooth, of a dark-red or blue color, and consists of the constricted inner

layer of the foreskin. The second is made up of the folded outer layer, and between the two is the offending preputial ring. Usually the latter cannot be seen until the skin of the penis is retracted. If the frenum is very long, the site of the constriction may lie behind it in exceptional cases. The glans becomes markedly swollen, sometimes to double its normal size, the congestion and discoloration of the inner layer of the foreskin increase, and resolution may come about by partial gangrene of the latter—the sloughing process rarely involving the glans itself. If ulceration of the constricting ring occurs, the circulation is restored spontaneously and a reposition of the parts takes place without assistance. The course of the condition described is quite typical and the proper diagnosis is evident. The only question which may arise is the presence of a constricting foreign body. The condition of the frenum may serve to differentiate the two, for in paraphimosis it may be traced as a tense band extending from the meatus to the edge of the prepuce.

The prognosis is favorable if the proper treatment is instituted, otherwise gangrene followed by cicatricial contraction may bring about considerable deformity.

Treatment.—It is possible in many cases to replace the glans without resorting to operative procedures. After the glans has been made smaller by compression, aided if necessary by needle punctures, it may be forced through the constricting foreskin, which is firmly held by the index and middle fingers, while the thumb exerts pressure against the anterior surface of the glans. There may be a preliminary application of ice or wet compresses. If this treatment is not successful, the ring must be divided by a deep dorsal incision before the glans can be restored to its normal position. In a few days the local swelling subsides under appropriate treatment, and then the phimosis which originally caused the trouble must be removed by operation.

Cellulitis.—Phlegmonous processes of the skin and the subcutaneous connective tissue are preceded by a lymphangitis in the form of the well-known painful red streaks usually found at the root of the penis. Injuries of the penis and their complications, such as urinary infiltration, are the common causes of this condition. The treatment consists in rest and the application of wet dressings, and abscesses must be opened at once. The process is nevertheless liable to be followed by gangrene of the skin, and the resulting defects may require covering by the formation of plastic flaps. Similar causes, in addition to acute inflammations of the urethra (gonorrhœa), also lead to inflammation of the corpus cavernosum, a cavernitis, with possibly abscess formation. It develops as a circumscribed tender infiltration in the inferior half of this structure, which attains the size of a pea or a cherry, with or without an accompanying rise in the temperature. In a few days a well-marked abscess may be formed; then the process spreads, and occasionally in a severe case

may cause diffuse suppuration followed by gangrene of the penis. When the process takes such an unfavorable course, the earliest symptom, aside from the high temperature and swelling of the penis, is usually a painless priapism. Palpation is not necessarily painful, and the infiltrated corpora can usually be made out. Pyæmia has often been known to follow suppuration or gangrene of the corpora, and in such cases the prognosis is very doubtful. Treatment consists in extensive, deep incisions made as early as possible, and supplemented by measures directed to supporting the general condition of the patient.

Cavernitis.—The term chronic cavernitis has been applied to circumscribed indurations in the septum between the corpora on the dorsum of the penis in front of the symphysis. (Kaufmann.) This condition becomes evident during the state of erection. At the site of the induration the penis is sharply bent and painful. The so-called fibrous nodes or ganglia of the corpora cavernosa produce very similar symptoms. They are usually found on the inferior aspect of the organ, situated in the corpora, in the bulbous or the cavernous portion of the urethra, and may number six or seven nodules disposed in a row and of the size of a plum-pit or a cherry-pit. When several nodes are present, the penis becomes bent in various directions, even spirally, and discharge of the semen is interfered with. The cause is believed to be an inflammation of the corpora following chronic gonorrhœa, gout, or phlebitis. Treatment consists in attempts at inducing absorption of the induration, for which baths, wet applications, mercuric ointment, tincture of iodine, and potassium iodide internally have all been recommended. The differential diagnosis is concerned primarily with gummatous processes, and the decision must be based on the effects obtained by specific treatment. A beginning carcinoma may also come into question. These fibrous indurations undoubtedly stand in some close relation to the calcifications and ossifications of the penis described in a preceding chapter.

Erysipelas.—Erysipelas rarely starts in the penis, but usually extends to the latter organ from the scrotum or the abdomen. It is frequently complicated by abscess and extensive gangrene of the skin. The treatment is the same as that for a similar process in other parts of the body, and resulting skin defects must subsequently be covered by plastic flaps. Gangrene of the penis, in addition to that caused by injuries, constrictions, phlegmonous processes, erysipelas, phagedenic and serpiginous chancre, may also result from diabetes, typhoid, malaria, or influenza, in individuals who are much debilitated. The necrotic process may be limited to the skin, or it may involve the entire thickness of the penis, particularly the corpora cavernosa; but the fibrous envelopes of the latter offer the most prolonged resistance. A spontaneous type of gangrene, of doubtful origin, has also been described by Fournier and others. The treatment is

directed toward prevention of the spread of the gangrenous process by making suitable incisions, and after demarcation has resulted the necrotic portion may be removed. Later, plastic operations may be required to cover up resulting defects in the skin. The prognosis is always rendered doubtful by the danger of a general sepsis.

Elephantiasis.—Elephantiasis of the penis and foreskin likewise depends on previous chronic inflammatory conditions, and suspicion has been particularly attached to recurring erysipelas, lymphangitis, tuberculosis, balanitis, and syphilis. In other instances strictures,

FIG. 309.

Elephantiasis of the penis. (Taylor.)

trauma, and excision of the inguinal glands have preceded the appearance of the disease. The condition is a rare one, even in those localities in which elephantiasis is endemic. It may be confined to the prepuce or to the penis (Fig. 309), but in severer cases it may invade the scrotum. The hyperplasia of the skin and connective tissue gradually gives to the organ dimensions which are burdensome. At first the annoyances are very slight, but in course of time the patients are greatly troubled by their affliction. The prognosis is in general unfavorable, and only in selected cases in which the disease has not spread very far, should ablation of the prepuce be attempted with subsequent formation of flaps. When the growth is more extensive, amputation of the penis is indicated, and when there is a possibility of a syphilitic origin antisyphilitic treatment must be tried.

Tuberculosis.—Tuberculosis of the prepuce has frequently been observed in the form of an ulceration along the edges of the wound after ritual circumcision. Lehmann observed in direct succession 15 cases in which the lesion occurred, the individual performing the ceremony being a subject of advanced phthisis. He applied his lips to the wound for the purpose of checking the bleeding. Cases of primary tuberculosis of the glans, in the form of an ulcer with caseous degeneration, have also been seen, and in that reported by Kraske tubercle bacilli were demonstrated microscopically. Treatment consists in local curettage, or amputation of the glans if the process is more extensive.

For a discussion of the primary and secondary syphilitic affections of the penis the reader is referred to the works which deal with this subject exclusively, but a brief mention will be made of gumma as found in this organ. It occurs in all parts of the penis—glans, prepuce, skin, and corpora cavernosa—but is extremely rare. It is represented by firm painless nodules about the size of beans, which gradually disintegrate and involve the urethra, in which they may cause strictures or fistulas.

TUMORS OF THE PENIS.

Cysts.—Cystic tumors of the skin and subcutaneous tissue are rarely encountered in the penis. Gerulanos has lately collected all the known cases and classified the tumors according to their etiology, as follows :

1. Traumatic epithelial cysts, which have been described by Trzebicky as complicating ritual circumcision.

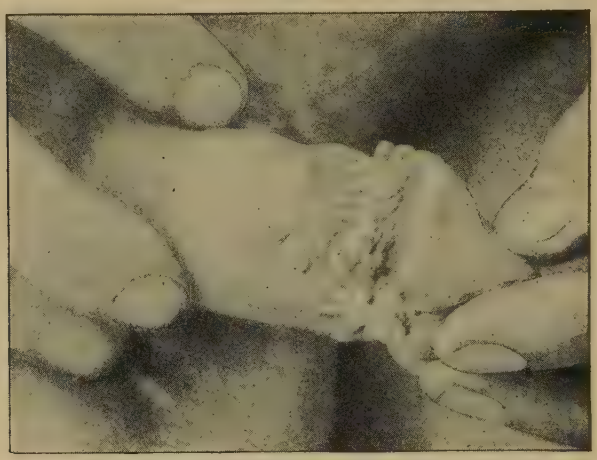
2. A single case of cystadenoma has been reported by Fischer, who pictures it as having arisen from the sebaceous glands. The tumor was as large as a cherry, with a broad base and situated on the inferior aspect of the prepuce, a little to one side of the median line. It contained a serous fluid.

3. The most numerous growths of this variety are the atheroma of the skin of the prepuce and of the upper surface of the glans. They are usually derived from the hair-follicles and less often from the sebaceous glands. They may be present in considerable numbers ; Busch saw twenty-three atheromatous cysts on the surface of the glans in one case. Larger atheromata have rarely been observed on the penis.

4. Dermoid cysts are congenital, situated generally in the median raphe, are of the size of a hazelnut or walnut, and often elongated in shape. They contain atheromatous material. These little growths are readily recognized. They may annoy the patient by their presence or they may even deform the penis. The only treatment is excision, care being taken to eradicate the sac completely in order to avoid recurrence.

Papillomata.—Papillary growths on the glans or foreskin (Fig. 310), or pointed condylomata, are only of surgical interest in so far as they, when neglected and permitted to increase in size, may closely simulate a papillary carcinoma. (Fig. 311.) The latter, however,

FIG. 310.



Soft vegetations in the coronal sulcus and near the frenum. (Taylor.)

are characterized by an indurated base and a tendency to ulceration. These growths should be removed with a pair of scissors and the base cauterized. Zielewicz has described an isolated case of

FIG. 311.

Exuberant warty growths involving the inner layer of the prepuce, the sulcus, and the greater portion of the glans (cauliflower appearance). (Taylor.)

papilloma of the penis, which consisted essentially of a hypertrophy of the papillary layer, similar to the elephantiasis verruca described by Virchow.

Cutaneous warts or keratoses are occasionally found on the glans.

Friedrich collected 21 reports of such cases up to 1891. The tumors form true horns or horny plates and irregular horny protuberances, usually in older people, rarely in the young, and almost exclusively in the region of the corona glandis. They sometimes attain a considerable size. Hebra reports an instance in which the growth was 10.5 cm. (4.5 inches) long. Microscopically these masses are seen to be made up of epidermal cells closely crowded together, which gradually lose their nuclei in the more superficial layers. Around the base they become transformed into normal epithelial cells, and may extend into the deeper layers in the form of finger-like projections. The main etiological factor in the development of these growths is a phimosis (observed in 11 cases); while contributory causes are mechanical irritation, injuries, or lack of cleanliness. As carcinoma is liable to follow one of these growths situated in other parts of the body, the prognosis is more or less doubtful, and radical operation rather than palliative measures is to be recommended. A free excision should extend into the healthy tissue, and in most cases amputation of the glans needs to be considered.

Angiomata.—Chronic diseases of the bloodvessels and the lymphatics of the penis are rare. Malgaigne has described an aneurism of the dorsal artery following a punctured wound. Here and there angiocavernomata have been observed in the glans. (Longo.) Dilatations of the lymphatic vessels of the penis have been known to occur after trauma, from injury during coitus, and have also been attributed to lymphatic congestion following extirpation of the inguinal glands. Such dilatations appear as thickened circular cords on the dorsum of the penis, filled with a white, lymph-like fluid. The treatment consists in extirpation of the dilated vessels.

Sarcomata.—Sarcomata are comparatively rare, and in either of the primary or the secondary forms may be made up of round, spindle, or mixed cells, either simple or melanotic. Fibrous or angiomatous varieties are rare. The tumors take their origin from the corpus spongiosum or the corpora cavernosa, the starting-point being in the connective tissue, the endothelium of the cavernous spaces, or in the tunica albuginea itself. They are found on the glans, or in the pendulous portion or in the perineal portion, as circumscribed nodules or as diffuse growths, which invade the prostate by direct continuity or by metastasis. Metastatic deposits are very apt to occur at an early stage in the inguinal glands, the testicle, and the prostate. Melanotic sarcomata have been observed more particularly on the glans. In the case illustrated in Fig. 312 the tumor was of a bluish-black color, of firm consistence, about the size of a hazelnut, and presented a smooth upper surface with the exception of two small beginning ulcers. A second smaller growth was situated on the dorsum of the penis near the coronal sulcus, and was apparently not connected with the other. A point of etiological significance is that two of three patients seen in the clinic at Halle gave a history of

injury of the penis. Among the severer symptoms which may be caused by the tumor is a gradual interference with urination, which also becomes very painful, and is due either to direct pressure by the tumor or to extension of ulcerative processes into the urethra. The penis assumes an abnormal form, and may be bent at the site of the firm and often sharply circumscribed tumor. With increasing growth, erection of the penis becomes impossible.

FIG. 312.

Melanotic sarcoma of the penis. (Payr.)

In making a diagnosis it is important to decide whether the tumor of the penis is primary or secondary. It may be distinguished from a carcinoma by its situation in one of the cavernous bodies, its outer configuration, and the lessened and delayed tendency to ulceration. The changes in the form of the organ, as outlined above, should also be taken into account. In one of the author's cases the sarcomatous nodule had ulcerated into the urethra, and the diagnosis could be readily confirmed by an examination of the tissue-masses secured through a catheter.

The prognosis if the tumor has not spread to any great extent is comparatively favorable, with the exception of the melanotic sarcoma. In one of the author's cases amputation was performed at the root of the penis in 1895, and up to date no recurrences have been detected. The extirpation of the penis must be complete, and needs to be supplemented by removal of the inguinal glands. In case an operation of a radical nature is no longer feasible, the resulting urinary difficulties should be relieved by the insertion of catheters or the passage of bougies—or it may be necessary to provide a vesical fistula.

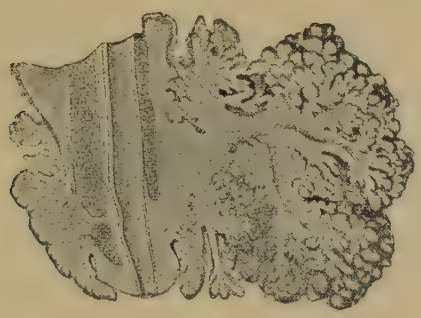
Carcinomata.—Carcinoma of the penis occurs more frequently than any other form of tumor of that organ, and includes about 3 per

cent. of all carcinomata met with in male patients. It is rarely found before the fortieth year of life, and the majority of the subjects are between fifty and seventy.

Etiology.—One of the most important etiological factors seems to be a congenital phimosis, with a tendency to the accumulation of secretions and a constant irritation caused by repeated slight inflammations. The so-called "psoriasis præputialis," first described by Schuchardt, seems to be a predisposing factor in the production of cancer. It is marked by the appearance of shiny, grayish-white plaques on the surface of the glans, and results from a chronic irritation. In many cases the development of a carcinoma has been traced from a small wart; in others a trauma, usually a contusion, has been considered the cause; and, finally, long-continued specific ulceration of the glans and foreskin may undergo carcinomatous degeneration. Heredity is apparently not an important factor.

According to Küttner, whose admirable presentation of the subject will be followed here, three main types of cancer of the penis may be distinguished. The boundaries are in many cases, however, not sharply marked. These types are: 1, the papillary cauliflower growth; 2, the carcinomatous ulcer; 3, the non-papillary cancer.

FIG. 313.



Section of a cauliflower carcinoma. (Küttner.)

The cauliflower growth occurs frequently in the presence of phimosis, and develops on the glans or the inner layer of the prepuce. It usually extends rapidly over both by direct invasion rather than by contact infection. The prepuce is perforated at one or more places by the growing tumor, and as the latter increases in size, it is gradually destroyed and the greatly altered glans becomes exposed to view. Less frequently this form of tumor develops from the outer layer of a phimotic prepuce. When there is no phimosis present, the new growth usually starts from the glans, beginning in a small wart-like nodule, which enlarges rapidly, or there are fresh excrescences developed in its vicinity. After this the foreskin cannot be drawn forward over the tumor; or if the prepuce has been the

site of the growth, the increasing infiltration produces a kind of secondary phimosis. The papillæ may be of various shapes and sizes, so that the resulting tumor both outwardly and on cross-section bears a very close resemblance to a cauliflower. (Fig. 313.) The papillæ are soft if exposed to the urine or to the retained secretions, under a phimotic prepuce, but are much firmer if exposed to the air. Disintegration results with increase in the growth of the tumor. The urethra is gradually invaded, and piece by piece the growth sloughs away from the penis, until the extension of the neoplasm over the scrotum and the pubic region destroys all vestiges of the organ. (Fig. 314.) The urine then is discharged from one of the numerous crater-like depressions.

Fig. 314.

Complete destruction of the penis, the carcinomatous ulceration having extended over the scrotum and pubic region. (Case seen at the clinic at Halle.)

The second type of carcinoma, the carcinomatous ulcer, occurs much less frequently. Although present only as a relatively small hard ulcer on the glans or in the coronal sulcus, with overhanging edges, it may be accompanied by extensive metastases. In other cases the glans and foreskin are converted into a deep, sloughing mass, and the further course is the same as that in a cauliflower growth.

The third type of carcinoma has been observed only in isolated instances. It is non-papillary and apparently very malignant. It involves the glans and may reach the size of a closed hand. A cross-section shows the absence of any papillary arrangement, but discloses a condition similar to that seen in cancer of the breast.

Cancer of the penis may invade the scrotum, testicles, prostate,

bladder, rectum, and pelvic bones before it leads to a fatal issue. The histological findings are the same as those in a carcinoma of the skin in other parts of the body. The method of extension of this growth has been carefully investigated by Küttner. He believes that the vascular system, especially the corpus cavernosum, is of the greatest importance in this connection, and was able to show that the growth extended by direct continuity, as well as by individual nodules, into the corpora. This latter phenomenon is well shown in Fig. 315. The metastatic extension occurs almost exclusively through the medium of the lymphatic vessels and produces an infection of the neighboring lymphatic glands. Internal metastatic

Fig. 315.

Scattered carcinomatous nodules in the corpus cavernosum. (Küttner.)

deposits have rarely been seen. The inguinal glands are usually the first to be involved, less frequently the retroperitoneal group. In the latter case their primary invasion is due to the fact that among the numerous lymphatic channels connected with the penis certain ones lead directly to the interior of the pelvis without communicating with the inguinal glands. The time at which lymphatic involvement takes place varies greatly. Very often, while the tumor is still small, there are large masses present in the glands, but in other cases the growth may have caused extensive destruction of the penis, without any metastatic deposits being visible.

Symptoms.—In only rare cases are the pains produced by cancer of the penis in its early stages sufficiently severe to lead the patient to consult a physician. As the growth increases in size sharp pains

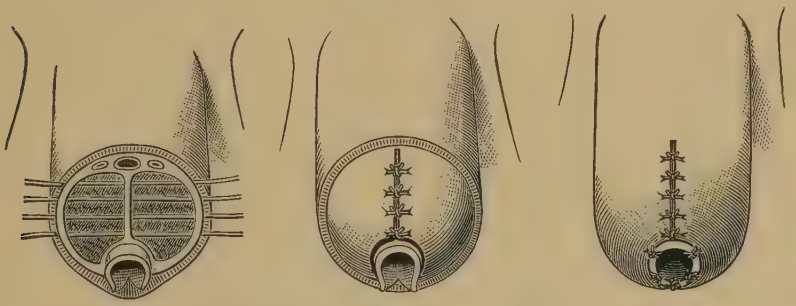
are felt, which radiate from the glans toward the groin or the inguinal region, and are caused by the ulceration itself or by the passage of urine over the ulcer. If phimosis is present, there is a foul-smelling purulent discharge from the opening, which resists all treatment. Foul and irritating secretions are also associated with a disintegrating cancerous ulcer of the outer parts. Strangely enough, there are some patients afflicted with this malady who manifest a marked indifference to these annoying symptoms. In certain cases gradual interference with urination comes on, due either to extension of the growth into the urethra or to displacement of the external meatus by the neoplasm. In the latter case the hindrance to micturition disappears when the obstructing masses have sloughed away. In advanced cases hemorrhage from the meatus has occasionally been observed, and erection is very painful.

Diagnosis.—When the ulcerative process is well advanced, the diagnosis is not difficult. In the early cases it is necessary to exclude, particularly if the cauliflower growth is in question, pointed condylomata, which may coalesce and form palpable tumors when neglected. The base, however, is soft and the cause is almost always a gonorrhœa. An ulcerating primary syphilitic lesion, especially in old people, may be confused with cancer, and it is advisable to try the effect of a course of mercurial inunctions for a few weeks. Severe forms of phagedenic chancres may bear a close resemblance to carcinomatous ulcers. In these cases energetic local treatment, including curettage and cauterization of the affected area, will soon decide the point at issue. The greatest difficulty, however, attends the recognition of a carcinoma which begins to develop under a phimotic prepuce. Kaufmann has well said that the possibility of a cancer must always be borne in mind when an old man presents a phimotic condition of the foreskin with a foul-smelling discharge from the opening. Careful examination often discloses the firm induration under the prepuce, and sometimes its extension can be made out in the form of an infiltration in the central portion of the corpora cavernosa. Enlargement of the glands in the inguinal region should also be taken into account. Finally, the diagnosis may be confirmed by simply dividing the foreskin and exposing the tissues underneath.

Prognosis.—The prognosis is entirely dependent on the extent of the involvement of the regional lymph-glands. If the latter are still intact, the operative removal of the growth affords favorable chances for a prolonged or even a permanent cure. If, on the contrary, the lymphatic involvement is evident, or the neoplasm is growing rapidly and destroying the penis, the prognosis is extremely unfavorable, and especially if the patient is comparatively young. Recurrences at the site of operation come on quickly and are frequently seen. The glandular swellings also grow rapidly, and are prone to ulcerate at an early stage. The treatment is therefore

limited to excision of the growth, together with the extirpation of the glands in the groin, even if these have not been involved. A procedure of this kind is entirely dependent on the general condition of the patient. If the glands are markedly enlarged and tightly adherent, all that can be done is to excise the sloughing cancerous ulcer, provided the latter has not extended beyond the limits of the penis.

Fig. 316. Fig. 317. Fig. 318.



Partial amputation of the penis. (Hartmann.)

Fig. 319.

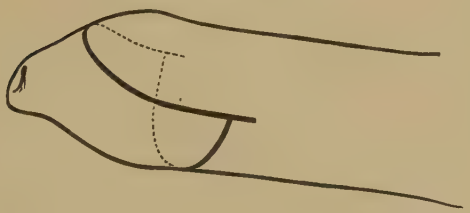


Fig. 320. Fig. 321.

Amputation of the penis by the formation of a flap. (Hartmann.)

Treatment.—The fear of an uncontrollable hemorrhage led the earlier operators to amputation of the penis either by slow constriction by means of a tightly applied band, a catheter being at the same time kept in the urethra, or by incisions carried out with a cautery knife, or an écraseur or by a thermocautery. These methods have been abandoned.

Amputation by means of the knife is performed as follows: After thoroughly disinfecting the site of the operation and the surrounding area, the diseased portion of the penis is wrapped up in bichloride of mercury gauze. A bloodless field of operation is secured by the usual means. The surgeon then seizes the penis at the tip and carries a circular incision around the organ down to the albuginea. The incision is then carried through the corpora cavernosa down to the urethra—the septum having first been fixed with a retaining suture so that retraction of the corpora cannot take place. The urethra is then divided. The large arteries are clamped and tied, and the oozing from the corpora cavernosa can be best stopped by suturing their enclosing fascial coverings with a few deep sutures and thus bringing them together in front. (Figs. 316 and 317.) The skin-edges are approximated over these buried sutures. (Fig. 318.) In order to avoid a narrowing of the urethral opening the canal is incised for the distance of about 1 cm. from before backward, and the mucous membrane sutured to the skin.

Hartmann's flap amputation is illustrated in Figs. 319, 320, and 321.

To obviate stricture at the new orifice, Bardenheuer has proposed that the urethra be left intact, but allowed to project about 2 cm. from the wound. During the process of healing, the urethra retracts of its own accord, but leaves a wide opening. When it becomes necessary to divide the penis at the root, or in the bulbous or membranous portion of the urethra, it is advisable to split the scrotum and to dissect out the penis in its entirety. After the suspensory ligament and the pubic attachments are divided, the organ is extirpated far from the site of the disease. The corpora may be fixed in the same manner as in the preceding case and the hemorrhage checked at leisure. The urethra should be divided on a more distal plane if possible, so that it can the more readily be implanted in the perineum at the lower end of the skin-incision. The end is split and the mucous membrane sutured to the edges of the wound in the scrotum, and the latter is sutured. The inguinal region may be cleaned out at once or later. Complete emasculation is indicated only in case metastatic deposits are likewise present in the testicles.

ANOMALIES, INJURIES, AND DISEASES OF THE SCROTUM, TESTICLE,[1] VAS DEFERENS, AND SEMINAL VESICLE.

By Prof. v. BRAMANN.

CHAPTER XXXIII.

CONGENITAL ANOMALIES OF THE SCROTUM AND TESTICLE.

The scrotum develops from two lateral folds which unite in the median line and form a raphe. If this union is imperfect, there will be a cleft in the median line, giving the scrotum something of the appearance of the labia majora of woman, a condition which has sometimes been mistaken for hermaphroditism. It may or may not be associated with hypospadias. Such abnormalities as a persistence of infantile scrotum, or the failure of one-half the scrotum to develop, are almost invariably due to lack of development of the testicle within the scrotum—a condition known as undescended testicle.

UNDESCENDED TESTICLE.

The normal process of descent may be interfered with, so that the testicle remains in its original position in the abdomen, or it may descend only as far as the inguinal canal, or just out of the canal; or into the upper portion of the scrotum. If one testicle remains in the abdomen while the other descends, the condition is that of monorchism. If neither testicle descends, the condition is spoken of as cryptorchism. This condition must not be confounded with anorchism, or the absence from the body of both testicles—a faulty development usually associated with rudimentary penis, and in which there is a complete failure of spermatic secretion.

Failure of the testicle to descend may be due to an imperfect development of the organ. The testis, or the epididymis, or the vas deferens may be wholly wanting or imperfectly formed; or the vaginal process may remain rudimentary. Those cases are particularly interesting in which, in spite of the absence of the testis, the epididymis and vas deferens develop normally and descend to the

[1] In this article the word "testis" is used to indicate the body of the organ, and the word "testicle" to indicate the whole gland as made up of testis and epididymis together.

bottom of the scrotum. Further causes of undescended testicle are peritoneal adhesions between the testicle and bladder, intestine, etc., as well as obstructions in the inguinal canal, and particularly the aponeurosis of the external oblique muscle; for, as this aponeurosis is not broken through, but is carried before the testicle in its descent, it may either delay or prevent altogether the descent of the organ.

Symptoms.—The most striking symptom of undescended testicle is the absence of one or both testicles from the scrotum. As a result the scrotum itself remains rudimentary and much contracted on one or both sides. Usually the undescended testicle can be found in the upper portion of the scrotum or in the inguinal canal. By careful palpation one can almost always demonstrate the presence of the vaginal process as a soft rounded structure 4 or 5 cm. (1.6 or 2 inches) in length, in which the testicle can be slipped up and down for a little distance. In these cases one may look for a complete descent of the testicle, although it may be much delayed. Sometimes the vaginal process is filled with fluid, making a cylindrical tumor (hydrocele). In very young children the process often communicates with the abdomen, so that by pressure the fluid within it can be squeezed back into the peritoneal cavity. In other cases the vaginal process connects freely with the peritoneal cavity and contains coils of intestine, omentum, etc. (congenital hernia). This condition is the usual one in those cases in which the testicle has descended only as far as the internal ring, or into the inguinal canal, so that the vaginal process has not pushed forward the aponeurosis of the external oblique. In these cases the presence of intestine, etc., dilates the vaginal process as much as the inguinal canal will permit; or the vaginal process may have been pushed up between the peritoneum and the transversalis fascia (preperitoneal hernia), or between the internal and external oblique muscles (properitoneal hernia). The first condition scarcely shows on the surface of the body, while the latter forms a more or less prominent swelling between the anterior superior spine and the external inguinal ring. In such cases the testicle can be recognized on palpation if the abdominal wall is not too fat. Furthermore, pressure will give the characteristic testicular sensation even when the testicle is as far up as the internal inguinal ring. In cryptorchism the testicle can scarcely be palpated above because it is covered by a thick layer of muscles, and because in these cases it is very movable and softer and smaller than normal.

Results of Undescended Testicle.—ATROPHY.—Atrophy of the testicle may be congenital, especially in cases of cryptorchism. It may also develop after birth on account of the unfavorable relations of an undescended testicle. Such are, in the first place, the frequent injuries which befall a testicle in the inguinal canal; and, in the second place, imperfect circulation of blood due to compression of the testicle and its vessels by the abdominal muscles or the contents of a

coexisting hernia. Sometimes atrophy is produced by an ill-fitting bandage or truss.

Finotti, who made microscopical examination in 7 cases of cryptorchism, found the seminal tubules more scanty and shorter than normal and the connective tissue more abundant. He also found an increased number of intervening cells, which he considered to be of a rudimentary character, proceeding from the embryonic period. These cells he thought might explain the frequency of malignant disease in an undescended testicle. Such a testicle, according to this observer, is not necessarily without function. The development which normally takes place at puberty begins in it at a later date, and the formation of semen is less abundant than in a normal gland. Wilson cites a case in which the infantile genitals of a man aged twenty-six developed after marriage until they appeared normal. Therefore it is unsafe to say, in the case of a child, whether a testicle is completely atrophic and incapable of ever performing its normal function. This point is further discussed under the head of treatment.

A testicle which has passed at birth through the inguinal canal, and in the course of some weeks or months has reached the bottom of the scrotum, will show no atrophy whatever. The only abnormality in such a case is a certain increased mobility of the testicle.

Abnormal Mobility.—When the testicle descends imperfectly or not so far as normally, the vaginal process remains open to a greater distance than normal. Furthermore, in these cases the testicle hangs free in the vaginal process, being held back posteriorly by the peritoneal reflection,—the mesorchium. For these two reasons the testicle is abnormally movable and may often be pushed back and forth into and out of the inguinal canal. Such a condition may be mistaken by a careless examiner for a hernia. It may, of course, be associated with a hernia, the vaginal process forming a hernial sac.

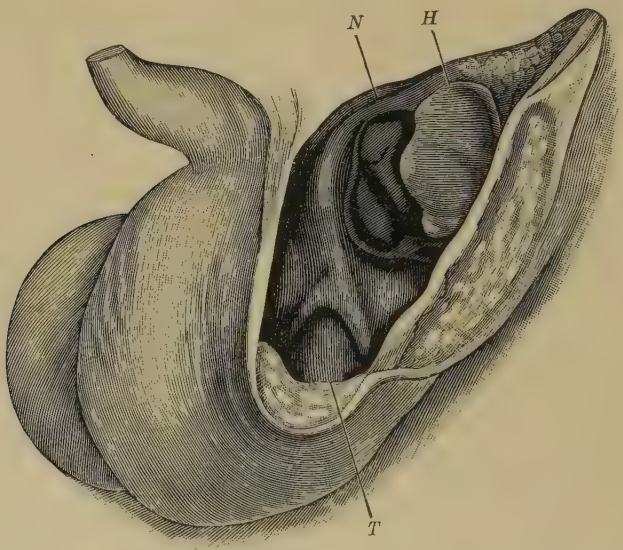
Twisting of the Testicle.—An undescended testicle may be twisted around its horizontal or its vertical axis. In the former case the upper end of the testicle sinks so far that its long axis is not horizontal, but is directed from in front upward and backward; or the testicle may be so twisted that its head is downward. If it is twisted on its vertical axis, the epididymis may lie at the side of the testis, or in front of it—a transposition which may be of great importance in making a diagnosis of an inflammatory condition or of a tumor. If the vas deferens is palpated and is followed to the epididymis, the surgeon will generally recognize the testis and epididymis however the testicle is twisted, and thus avoid wounding either with a trocar or scalpel.

A slight twisting of the testicle is of no significance. If the organ is twisted through 90 degrees or, as in some cases, through

180 degrees, the venous and arterial supply may be seriously interfered with.

The clinical symptoms of torsion are usually those of an acute local inflammation. There are intense pain and great swelling of the testicle and epididymis, and œdema of the soft parts which cover them. There are usually such general symptoms as dizziness, faintness, nausea, and vomiting. If the twisting is more marked and continues for a considerable time, there will be hemorrhages in the testicle and thrombosis of its vessels. The testis becomes a dark reddish-brown and the epididymis bluish red or black, while the latter especially is greatly increased in size. (Fig. 322.) There is almost always a serohemorrhagic exudate in the tunica vaginalis.

FIG. 322.



N, epididymis; *H*, testis; *T*, lowest portion of the tunica vaginalis.

The pathological anatomy and symptoms of twisting of the testicle are almost identical with those of infarct due to embolism. Indeed, in many of the cases of infarct hitherto described, the real cause of the trouble was probably a twist of the cord.

Various accidents have been mentioned as likely to cause a twist of the testicle, such as blows, sudden movements of the body, and increased abdominal pressure. Enderlin found the changes so great after a twist of twenty-two hours' duration that the testicle completely atrophied; and in another case it became necrotic after a twist of forty-two hours' duration. If the twist affects the testicle in the inguinal canal, it may be extremely difficult to differentiate this condition from one of strangulated hernia, especially as the testicle is

frequently accompanied by a hernia. The difficulty is even greater if a testicle previously situated in the inguinal canal is suddenly pushed out of the canal and becomes strangulated. The spermatic cord may be so pinched in the narrow inguinal ring that the symptoms of a twist will be produced; namely, marked disturbance of circulation, swelling of the testis and epididymis, extravasation and coagulation of blood. Such strangulation of the testicle may be favored by a twist of the spermatic cord. Examination of such a patient will show a long tense tumor in the inguinal region, as tense as a strangulated hernia, irreducible, and associated with the symptoms above described. Such a condition may be differentiated from strangulated hernia as follows: The testicle is not in the scrotum of the affected side; the tumor is far more sensitive to the slightest pressure than is the case in strangulated hernia; symptoms of ileus are wanting in most cases. If an undescended testicle is associated with a hernia, strangulation may take place in both structures at the same time. Hence the importance of speedy operation.

An undescended testicle is especially prone to attacks of acute inflammation. Whether such inflammation is of a traumatic or gonorrhœal character can be told by the history, by examination of the urethra, and by microscopical examination of any discharge.

MISPLACED TESTICLE.—An undescended testicle may find its way into a situation which it does not normally occupy either before or after birth. The vaginal process and testicle may work their way between the peritoneum and transversalis fascia until they emerge through the femoral ring (crural testicle).

The testicle may emerge from the inguinal canal and then descend toward the perineum, coming finally to lie either under the fold of the skin between the thigh and the scrotum (scrotofemoral testicle) or behind the scrotum between the raphe of the perineum and the tuberosity of the ischium (perineal testicle). Those cases in which the testicle lies beside or behind Poupart's ligament, but not in the femoral canal, should not be spoken of as misplaced testicle, but rather as undescended testicle, since the testicle is behind the aponeurosis of the external oblique, although by reason of the atrophy of this aponeurosis the testicle may seem to be directly beneath the skin. Such a condition is usually associated with properitoneal hernia—a complication which almost never exists in cases of misplaced testicle.

The causes of misplacement of the testicle are unknown. Perhaps the shrinking of the empty scrotum may divert the testicle into the perineum. A faulty insertion of the gubernaculum cannot be the cause, for there is no insertion of the gubernaculum in the meaning previously held.

The symptoms of misplaced testicle are in general similar to those of undescended testicle.

An undescended testicle is frequently the seat of malignant growths—sarcoma and carcinoma. This frequency is stated by Kocher as 1 in 1000. He cites 59 cases of such tumors, which occurred more often upon the right side than upon the left. Non-descent of the testicles also occurs more frequently on the right side.

Treatment.—In cases of complete cryptorchism in which neither the testicle nor the vaginal process has entered the inguinal canal, and the testicle is more or less protected behind the abdominal wall, no treatment is indicated. If a preperitonal hernia has formed between the peritoneum and transversalis fascia, a truss will usually relieve the patient. If there are symptoms of strangulation, the treatment should be that adapted to strangulated hernia.

If the testicle together with some abdominal organs is situated in the dilated vaginal process in the inguinal canal, a truss should not be worn lest its pressure injure the testicle. In such cases an operation should be performed for the radical cure of the hernia and in order to bring the testicle as far down at least as the external ring. The incision should follow the direction of the inguinal canal; the hernial sac should be opened and carefully separated from the spermatic cord; the contents of the hernial sac should be replaced within the abdomen, the neck of the sac ligated and divided, and the testicle stitched as near the bottom of the scrotum as its attachments will allow. If the patient is of advanced years, the testicle may be removed; but in all young persons, and especially in boys who have not reached the age of puberty, castration should rarely be performed, as numerous observations show that an undescended testicle may develop so as to be functionally active, especially if it can be brought down into the scrotum before the period of puberty. This applies particularly to a testicle found in the inguinal canal. Langenbeck recommends massage and manipulation to facilitate descent of the testicle so placed, and such treatment has many times succeeded. A U-shaped truss is of service in holding the testicle down, and by its pressure facilitates closure of the vaginal process above the testicle.

More recently operative treatment has been given the preference over treatment by massage and truss, and many surgeons have reported success as the result of suture of the testicle, or orchidopexy. An incision is made from the internal ring to the lower end of the scrotum; the testis and epididymis are freely exposed, and the vas deferens is isolated high up. The tunica communis is cut across above the testicle and sutured. The vaginal process is ligated high up, divided, and sutured. Its lower cut end should be sutured, as stated, so as to complete the tunica vaginalis around the testicle. The testicle itself is stitched to the bottom of the scrotum. If it shows a tendency to draw upward, the spermatic cord may be stitched to the external ring, care being taken to avoid wounding the vas deferens.

This operation may relieve the patient of the severe pain often caused by the presence of the testicle in the inguinal canal. Just how far it will restore the function of the testicle and prevent subsequent atrophy remains to be determined. Broca performed orchidopexy 158 times without a single death. The results in 79 cases were known from one to six years after operation. In one case there was recurrence, in a second case subsequent castration was necessary on account of pain; while in 13 cases the testicle underwent atrophy. In the remaining 64 cases the testicle developed normally. If the patient is first seen after puberty, no operation is indicated unless there are annoying symptoms. If there is pain due to inflammation or new growth, the testicle should be removed, and in these cases it is almost always atrophic. If the spermatic cord twists or the testicle otherwise becomes strangulated, an immediate operation is indicated. If the condition of the testicle is such that its preservation is deemed advisable, it should be so sutured to the scrotum that a recurrence of the strangulation will not be possible. An attempt to untwist the testicle without cutting through the skin is an uncertain procedure, and may aggravate rather than relieve the condition. If the testicle is situated elsewhere than in the inguinal canal, it should be treated in accordance with the principles given above. If such a testicle is found to contain a new growth, the whole gland should be removed, together with a considerable portion of the spermatic cord—at least as high up as the external ring. Prognosis after radical removal of a sarcomatous testicle is relatively good. A carcinoma is more likely to recur after removal. The condition known as congenital hydrocele is described under Hydrocele.

CHAPTER XXXIV.

INJURIES AND DISEASES OF THE SCROTUM.

The skin of the scrotum forms a purse-shaped continuation of the skin of the abdomen, but is distinguished from it by its pigmentation, and by a thick layer of smooth muscular fibres, which produce the strong contractility and wrinkling of the skin. This muscular layer, called the tunica dartos, which also forms chiefly the septum of the scrotum, is separated by an abundance of loose connective tissue from the tunica vaginalis; but, on the other hand, is united with it through the branches of the cremasteric arteries and the scrotal arteries, and also the accompanying veins. This is especially so on the posterior and outer sides of the testicles and epididymis, as already pointed out. Both layers of the scrotal skin are rich in bloodvessels and in lymphatics.

INJURIES OF THE SCROTUM.

Because of this vascularity a severe contusion with a blunt object is followed by an extensive effusion of blood into the skin and into the loose connective tissue under the dartos. But, on the other hand, resorption of the effused blood, especially under the network of the contractile dartos, takes place more quickly than in other places. The extravasation of blood generally occurs after a blow or kick, or a fall upon a sharp corner, etc. Immediately after the contusion the scrotum swells, either on one or both sides, and the skin becomes tense and of a blood-red or blackish color. The discoloration extends over the whole scrotum, and possibly into the perineum or upon the upper portion of the thigh or into the inguinal region. The intense swelling of the skin may produce vesicles and excoriations. Severe pain does not usually follow simple contusions of the scrotum.

Subsidence of the swelling takes place quickly, and only in rare instances hæmatoma of the scrotum persists between the dartos and the common tunica. It is advisable to treat this by puncture or an incision, and evacuation of the coagulated blood. The usual treatment consists in placing the patient in a horizontal position, elevation of the scrotum by means of a pillow, and compression by means of a well-padded suspensory. In cases of marked redness and swelling of the skin a wet dressing, moistened with a 1 per cent. aluminum acetate solution, serves a good purpose. The ice-bag must

be used with great caution, and should never be placed directly upon the skin lest it produce gangrene.

Wounds of the scrotum are generally crushing and tearing wounds, and very seldom punctured and incised wounds. On account of the great elasticity of the skin, the edges of the wound are drawn widely apart, so that the wounds appear to be much greater than one would naturally expect from the injury. Gunshot-wounds of the scrotum are generally combined with wounds of the testicle, and especially of the spermatic cord. Among 568 shot-wounds of the scrotum compiled by Otis from the records of the American Civil War, these complications were found in nearly two-thirds of all the cases. The early theory that the testicle gets out of the way of the shot, appears, therefore, not to be true, at least in the case of the modern small arms. In greater wounds, especially those which run diagonally, one or even both testicles may appear at the opening, covered only by the tunica propria and albuginea, where, on account of the contraction of the edges of the wound, they may be more or less strangulated.

The treatment of wounds of the scrotum must be carried on with the strictest antiseptic or aseptic precautions, in order to avoid the infection which, on account of the large supply of blood- and lymph-vessels, easily and quickly spreads to the surrounding soft tissues. In recent and clean-cut wounds after disinfection, sutures may be introduced passing only the skin and tunica dartos without drainage. In old and crushing and infected wounds the edges of the wound must be freshened, the crushed or already necrosed tissue must be cut away, and the wound either sutured or kept open by means of a tampon of iodoform gauze. For the retention of the tampon and in order to prevent too great gaping of the edges of the wound, some stitches about 1 or 2 cm. (0.4 or 0.8 inch) apart, inserted over the tampon, may be employed. The stitches should be tied with a slip-knot in order that after removal of the tampon in three to five days they may be changed into permanent stitches.

Injured prolapse of the testicle may be treated in the same manner. If the testicle is already protruding, the granulations must be snipped off, the overhanging edges of the skin cut away, and the testicle replaced through the enlarged wound in the scrotum, and kept in position by a tampon, or a suture of the wound.

INFLAMMATION OF THE SCROTUM

Inflammation of the scrotum occurs in consequence of small wounds, excoriations, insect stings of the scrotum itself, or from spreading acute and deep injuries of the penis, urethra, and the perineum. This is especially true of erysipelas of the scrotum, which has a sudden onset in a typical manner and runs its course with severe constitutional disturbances. On account of the strong

pigmentation of the skin, the erysipelatous blush may easily be overlooked, but the pain and swelling are always present.

The treatment of erysipelas is the same as in other parts of the body. On account of the tense swelling of the skin, scarification and even deeper incisions may be necessary. In consequence of the great richness in lymph-spaces and lymph-vessels streptococci may spread rapidly and fill the lymph-vessels to such an extent that the resulting infiltration interferes with the circulation of the blood and produces gangrene. This may often be of considerable extent, and not infrequently reaches as far as the skin of the penis and the region of the groin.

The most severe forms of gangrene, both as regards local appearance and general constitutional disturbance, are observed in connection with phlegmonous inflammations of the scrotum, which, in contradistinction to erysipelas, never occur from small superficial wounds of the skin, but usually in consequence of sloughing and phagedenic sores on the penis, or as a result of suppurative inflammation of the corpora cavernosa; or infiltration of urine after a recent wound; or very tight strictures of the urethra; or after gangrenous paraproctitis. These run their course much more violently than erysipelas, with symptoms of severe sepsis, high fever, delirium, etc. The scrotum swells quickly, the skin becomes dark red and deeply infiltrated. The inflammation extends rapidly into the cellular tissue of the abdomen and the upper portion of the thighs, and not infrequently involves the testicles and spermatic cords. In such cases it often extends along the cord to cause a phlegmonous inflammation of the pelvis, and even peritonitis. In cases of such severe infection, and especially when infiltration of urine is associated with phlegmonous paraproctitis, often in a very short time formation of gas takes place in the infiltrated tissue. This is easily diagnosticated by the typical crackling under palpation, and by the tympanitic sound with percussion. In these cases rapid and extensive gangrene of the skin takes place, which may extend to the testicles, so that, in many cases, the entire skin of the scrotum, and also the sheaths of the testicles and spermatic cord, may be destroyed.

The treatment of these specially severe inflammatory conditions consists in making at the earliest possible moment cuts running parallel to the vessels, beginning over the skin of the abdomen in the region of the inguinal canal and parallel with the spermatic cord down to the bottom of the scrotum. The incisions should extend at least through the skin and the tunica dartos. In case the phlegmon is situated in the posterior segment of the scrotum the best plan is to make the incision in the raphe through the soft parts of the perineum. In case the inflammation has already extended along the spermatic cord into the inguinal canal, it is absolutely necessary to open the latter. Great damage to the scrotum

may be caused, so that one or the other of the testicles may be exposed; and later plastic operations, with flaps taken from the abdomen or thighs, may be necessary to make the covering for the testicles, to shorten the recovery, and to prevent atrophy of the testicle the result of cicatricial contraction.

TUMORS OF THE SCROTUM—ELEPHANTIASIS.

Œdema of the scrotum may be a symptom of general œdema occurring in diseases of the heart and kidneys, or it may be due to interference with the circulation through the spermatic cord. It is not infrequently seen in children, in whom it produces a waxy, translucent distention of the scrotum.

FIG. 323.

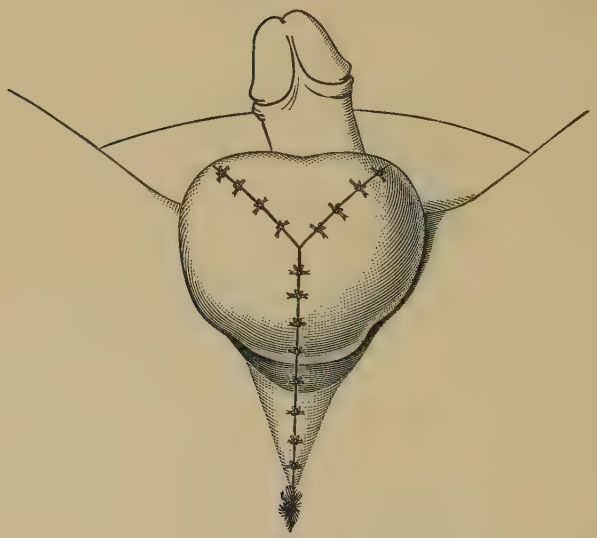
Elephantiasis of the scrotum. (Turner.)

Elephantiasis occurs to a marked degree only in the tropics, or in persons who have lived there. It is a thickening of the subcutaneous tissue with marked infiltration of cells around the bloodvessels. The walls of the bloodvessels and the sheaths of the nerves are also thickened. The lymph-vessels are greatly dilated and the lymph-glands are swollen. In some cases there are large lymph-spaces which are filled with fluid similar to lymph or chyle.

In elephantiasis of the scrotum the skin of the penis is almost always involved and the prepuce is greatly swollen. Sometimes the inflammation begins like erysipelas, with redness and swelling

Fig. 324.

Fig. 325.

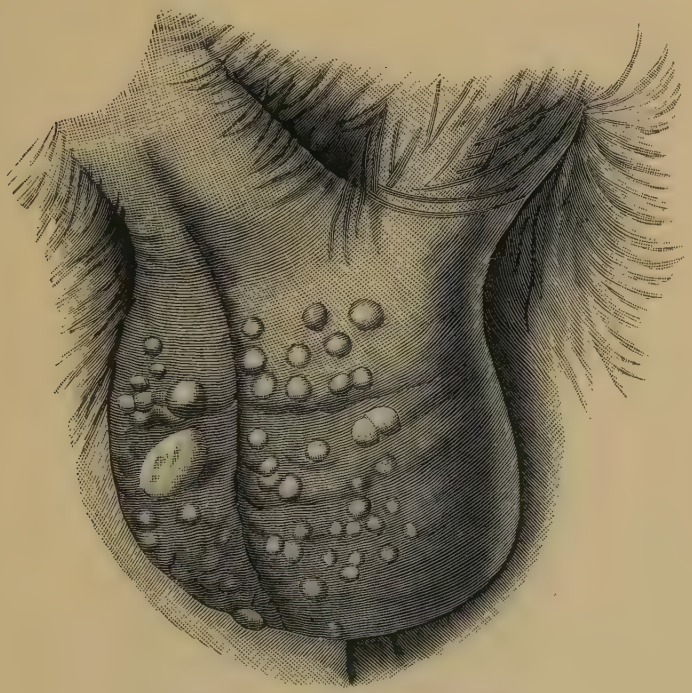


Resection of scrotum for elephantiasis—testicles remaining *in situ*. (Hartmann.)

of the skin, and swelling of the inguinal lymph-glands. There is only a mild fever, which may disappear in a few days. Such

attacks of inflammation recur frequently, and each attack leaves behind it a certain amount of infiltration of the scrotum until a tumor is formed which may weigh from thirty to fifty pounds, and cause the patient great annoyance. (Fig. 323.) In such cases the skin of the penis is entirely lost in the tumor, and the urine when passed trickles from a slit, so that the scrotal skin is constantly irritated by the urine. Sometimes blisters form in the skin which burst and discharge large quantities of serous and possibly milky fluid.

Fig. 326.



Sebaceous cysts of the scrotum. (Bramann.)

This disease frequently accompanies chyluria, and is due to the presence of filaria in the blood and lymph, as shown by Wucherer in 1866. It is capable of transmission by mosquitoes. It is especially prevalent in Egypt, India, and Samoa. In the last-named place one-half the adults are said to be affected by it. The treatment consists in the removal of a part or the whole of the tumor. (Figs. 324, 325.) Special clamps have been devised to hold the testicles up out of the way and prevent hemorrhage during amputation of the major portion of the scrotum. Enough skin must be left to cover the testicles properly.

In temperate zones a moderate elephantiasis of the scrotum

occurs in connection with elephantiasis of the lower extremities—a condition not accompanied by chyluria, and not due to filaria sanguinis. Bramann reports such a case occurring four years after an extensive dissection of the glands in both groins.

The benign tumors of the scrotum are chiefly of a cystic character. Tumors of the vessels and lipoma are rare. Serous cysts are not common, but sebaceous cysts are frequently seen. Sometimes they occur in great numbers, forming yellowish or reddish tumors as large as a pea or larger, and covered with thinned skin. (Fig. 326.) The best treatment is excision of the cyst and the skin which covers it.

FIG. 327.

Chimney-sweep's carcinomata of the penis and scrotum. (Bramann.)

Dermoid cysts are occasionally found in the scrotum, usually in the median line and near the perineum. They may extend well up between the urethra and rectum, and owe their origin to displacement of the ectoderm at the time of union of the genital folds, or the separation of the intestine from the urogenital sinus. A dermoid cyst is an elastic tumor sharply limited and giving a clear sense of fluctuation.

Sarcoma of the scrotum is rare. Carcinoma is relatively common, especially among chimney-sweeps and other persons who handle coal

and its products, such as tar, paraffin, etc. The coal soot lodges in the scrotal folds, where if it is allowed to remain a long time it sets up eczema ; the skin grows thick, the enlarged sebaceous glands stand out like black kernels, and constant irritation gives rise to the so-called soot warts, in the base of which carcinoma may develop. If so, the wart increases in size, its base becomes hard, its surface is excoriated and fissures and secretes freely, while the induration extends laterally and into the depth of the scrotum. Sometimes several such warts undergo carcinomatous change at once. They may be situated upon the penis as well as upon the scrotum. (Fig. 327.) The hands and arms of paraffin-workers may become similarly affected. The prognosis is good if these tumors are removed at an early stage before they have produced metastases in the inguinal glands, or in the glands along the spermatic cord, in the iliac fossa, etc.

The treatment of malignant tumor of the scrotum is its radical extirpation, together with careful dissection of the regional lymph-glands. Unless this is done, the glands increase in size, break down and form gangrenous cavities which may lead to sudden death through erosion of large vessels. If a carcinoma of the scrotum has extended to the penis or testicle, these structures should be removed by the methods previously described. Prophylactic treatment for workers in paraffin, tar, etc., is, above all things, cleanliness, and the prompt treatment of any eczema which may appear.

CHAPTER XXXV.

DISEASES OF THE COVERINGS OF THE TESTICLE AND OF THE SPERMATIC CORD.

The testis and epididymis are surrounded by a firm membrane, the tunica albuginea. The sides and front of the testis and a part of the epididymis are also covered by a membrane derived from the peritoneum, namely, the tunica vaginalis. This membrane also lines a part of the scrotum, so that it makes a closed serous sac into which the testicle appears to be pushed from behind. Outside of this is a fibrous layer derived from the transversalis fascia, and called the tunica communis. At the lower end of the testis and along the epididymis the tunica vaginalis and communis are intimately attached. Above the testicle and along the spermatic cord the layers are separated by loose connective tissue and a certain amount of fat, corresponding to the subperitoneal fat of the abdomen ; therefore, any effusion of blood which takes place between these two membranes separates them as far as the lower end of the testicle and the insertion of the vas deferens, and at the same time depresses the upper end of the testicle until it comes to occupy a horizontal position. Such a hemorrhage may extend upward along the cord into the inguinal canal or into the subperitoneal tissue and the inguinal fascia. The spermatic cord contains the internal spermatic artery, the artery of the vas deferens, the pampiniform plexus of veins, the nerves of the testis and epididymis, and the vas deferens. These structures are loosely attached to one another by connective tissue. They are surrounded by a fascial sheath, the tunica communis, whose outermost layer, sometimes called Cooper's fascia, is a continuation of the aponeurosis of the external oblique. This is again separated from the tunica dartos by a loose connective tissue.

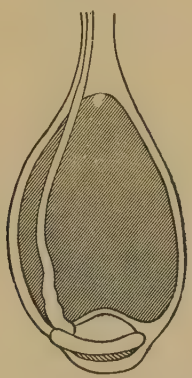
INJURIES OF THE MEMBRANES.

Hemorrhage into the loose connective tissue between the membranes may occur in the region of the spermatic cord or in that of the testicle. If in the latter situation, it is spoken of by Kocher as an extravaginal hæmatoma. Such a hæmatoma is usually small, whereas a hæmatoma of the spermatic cord may extend for a considerable distance, for example, from the testicle to the external ring. In such a case hæmatoma of the testicle usually exists, in which case the organ assumes a horizontal position, as already stated. (Fig. 328.)

Such a hemorrhage may result from contusion, or from increased blood-pressure due to abdominal strain. The vessel ruptured is usually a vein, although arterial hemorrhage is not unknown.

The symptoms of extravaginal hæmatoma are the sudden appearance of a tumor along the spermatic cord or beside the testicle, with pain, either spontaneous or on pressure, following the course of the spermatic cord. If the hæmatoma extends into the inguinal canal and the rupture has followed increased abdominal pressure, it may well be mistaken for a strangulated inguinal hernia; but characteristic of such a hæmatoma are the position of the testicle lying horizontally at its lower end and the impossibility of moving the testicle away from the tumor. Such motion is possible in the case of strangulated hernia.

FIG. 328.



Diffuse hæmatoma of the cord and testicle. The vas deferens lies at the left; below are the testis and epididymis. (Kocher.)

In rare cases after hemorrhage in the iliac fossa the blood may make its way between the layers of the spermatic cord to the testicle. Bramann saw such a hæmatoma form after rupture of an aneurism of the common iliac artery.

If the hæmatoma is not too large, the blood may be resorbed within a short time. If it becomes encapsulated, its resorption is interfered with; or, if the treatment is ill-advised, the quantity of blood may increase.

The proper treatment is absolute rest of the patient on his back with elevation of the scrotum. If the tumor increases in size, an ice-bag or a firm bandage should be applied if the pains are not increased thereby. The chief pressure should be made at the point where continued hemorrhage is suspected. If a tumor increases very rapidly so that the blood seems to come from a ruptured artery, an incision should be made, the blood-clots evacuated, and the ruptured vessel ligated. This treatment may also be demanded in case of encapsulated hæmatoma with little tendency to resorption of the

effused blood. When the blood-clots have been turned out, the cavity may be tamponed or partly closed by suture, and drained.

An intravaginal hæmatoma occurs less often than an extravaginal one; and, according to Kocher, it is usually secondary to the latter, the effused blood first stripping up the membranes and then tearing through the tunica vaginalis. Still, there are undoubted cases in which, as a result of a blow, hemorrhage took place within the cavity of the tunica vaginalis. Such is most apt to be the case if a hydrocele existed before the accident. In consequence of a hemorrhage the sac of the hydrocele will be greatly distended, becoming tense and painful. The testicle is wholly lost in the tumor formed by the effusion and cannot be recognized as in an extravaginal hæmatoma at the lowest point of the swelling. Usually the tumor appears flattened at its side and broader in front than behind. If there are symptoms of shock, vomiting, etc., injury of the testicle may be assumed to coexist. There is usually some evidence of contusion of the scrotum, or hemorrhage, etc., of the tunica vaginalis, which facts will serve to differentiate the condition from inflammatory troubles of the testicle.

Blood effused into the tunica vaginalis remains fluid for a long time unless the wall of the serous sac is badly torn.

Prognosis is less favorable than in extravaginal hæmatoma, since spontaneous resorption of the blood rarely takes place. Instead, the hæmatoma is followed by hydrocele or chronic periorchitis. Treatment consists in removal of the blood through a trocar, or through a short incision, as soon as the hemorrhage has ceased. In this manner the complications spoken of above may be avoided.

ACUTE INFLAMMATIONS OF THE MEMBRANES.

Acute Serofibrinous Periorchitis.—Acute inflammation of the tunica vaginalis is sometimes observed after injuries, especially in case the epididymis or the tunica was previously diseased. This is especially true of injuries following gonorrhœal infection; for this infection frequently extends from the epididymis to the tunica vaginalis. Acute hydrocele also occurs in connection with scarlet fever and other infectious diseases.

In such cases the tunica vaginalis contains cloudy serum and loose fibrinous clots which for the most part are easily detached from the membrane. Sometimes scanty granulations develop here and there on the surface of the membrane.

Symptoms.—The symptoms are more or less redness and œdema of the skin, and a swelling which covers chiefly the front, sides, top, and bottom of the testicle. This swelling is soft, but is extremely tender on pressure. The tumor thus formed is translucent if only a few fibrinous clots are present. If they are numerous, fibrinous crepitus may be obtained.

Except in children, the rise of temperature is slight, but is never wholly wanting—a point of difference between this trouble and hæmatoma, in which there is rarely any fever.

The outcome of acute periorchitis is for the most part favorable. In one or two weeks the exudate is resorbed and the serous surfaces come again into contact. As a rule there follows a chronic inflammatory condition which leads to chronic hydrocele.

Treatment.—Treatment consists in rest in bed, elevation of the scrotum, and the application of ice; or, if this gives pain, of cold wet dressings. If there is great tension, the sac should be punctured and irrigated with a 3 per cent. solution of carbolic acid or a 1 per cent. solution of aluminum acetate. If the pain continues and the swelling increases in spite of this treatment, the sac should be freely opened and drained.

Purulent Periorchitis.—Suppurative inflammation of the tunica vaginalis may follow acute serous inflammation, or it may be due to infection introduced through a wound. Thus a puncture performed without aseptic precautions may lead to suppuration in the tunica vaginalis. It may also follow inflammation elsewhere, such as a severe gonorrhœal epididymitis, or acute prostatic abscess. The tunica vaginalis is filled with pus and the injected and infiltrated serous membrane is abundantly covered with fibrinous deposit. The symptoms are more violent than those which occur in the serous periorchitis. The rise of temperature is greater and lasts longer. The scrotum is more swollen and intensely tender, especially in those cases in which the pus perforates the tunica vaginalis and spreads in the surrounding tissue. Such a complication may lead to extensive cellulitis.

Treatment.—Treatment consists in early evacuation of the purulent exudate through a long incision. The cavity of the tunica vaginalis should be tamponed or drained. Any sinuses should also be split open and drained.

Acute Hydrocele of the Spermatic Cord—Acute Serous Perispermatitis.—This condition can only develop in case a part of the vaginal process remains pervious. It may follow a blow or fall, or it may develop secondary to an inflammation of the urethra, neck of the bladder, prostate, etc. The exudate after injury is usually serohemorrhagic.

Symptoms.—The chief symptom is the sudden development of a tender elastic tumor somewhere in the course of the spermatic cord, which closely simulates a strangulated hernia. There are, however, no symptoms of ileus, although in some cases the severity of the injury may lead to vomiting and obstipation. The tumor is always more movable than a strangulated hernia. Furthermore, it frequently occurs in childhood, and strangulated hernia in children is rare. In doubtful cases an incision may be required to establish the diagnosis. Recovery usually follows rest, cold applications, etc. If the pain is great, the sac may be aspirated and irrigated.

Acute hydrocele of the cord may develop in the case of chronic inflammation.

Acute suppurative inflammation of some remnant of the vaginal process develops only in pre-existing hydrocele of the cord as a result of infection from without, or the extension of a suppurative inflammation from the neighborhood.

CHRONIC INFLAMMATIONS OF THE MEMBRANES.

Chronic Serous Periorchitis. Hydrocele.—Chronic inflammation of the tunica vaginalis is one of the commonest surgical troubles. It occurs on the right and left sides with about equal frequency; or it may affect both sides at once. The trouble occurs most often in patients between the twentieth and thirtieth year, then in those below the twentieth year; while the number affected decreases as age advances. According to Krönlein, 40 per cent. of the cases occurred in the first year of life, while about 50 per cent. occurred in the first five years. The statistics of different observers vary considerably in this matter.

In many cases hydrocele seems to develop spontaneously, so that its inflammatory character has been denied. Recent observers, such as Kocher, Langerhans, König, and others, have found evidences of inflammation both in the accumulated fluid and in the wall of the sac. The cause of this chronic inflammation is often a traumatism. Esmarch considered this to be the case in 30 per cent. of his cases, Kocher in 47 per cent., and Volkmann in 70 per cent. Doubtless the occurrence of so many cases of hydrocele in the first year of life is due to traumatism during or after birth. Another cause of hydrocele is the previous existence of inflammatory processes, such as those described in the first part of this chapter. In operating upon a hydrocele the surgeon not infrequently finds remains of a blood-clot or ecchymoses in the tunica vaginalis, showing the previous existence of a trauma.

The second most common cause of hydrocele is gonorrhœa and its complications, especially acute epididymitis. Baum, Langenbeck, and Volkmann assign this as the cause of 12 per cent. of the cases of hydrocele, while Barthel reckons the percentage at 19. The hydrocele may develop while the acute inflammation still exists, or it may follow at a later period when traces of gonorrhœa are still existent.

In children phimosis is a cause of hydrocele as shown by the fact that the cure of a phimosis is often followed by the spontaneous disappearance of a hydrocele.

Another cause of hydrocele is the occurrence of small retention-cysts (spermatocele) either in the testis or epididymis. Finally, there are sometimes found free bodies in the tunica vaginalis, especially after hemorrhage, which by their presence may irritate the serous membrane and give rise to exudation in the same manner

as loose cartilages produce exudation in a joint. Klebs was of the opinion that obstruction of the venous circulation might produce a hydrocele, but this seems doubtful since hydrocele rarely complicates a varicocele. In some cases hydrocele is congenital.

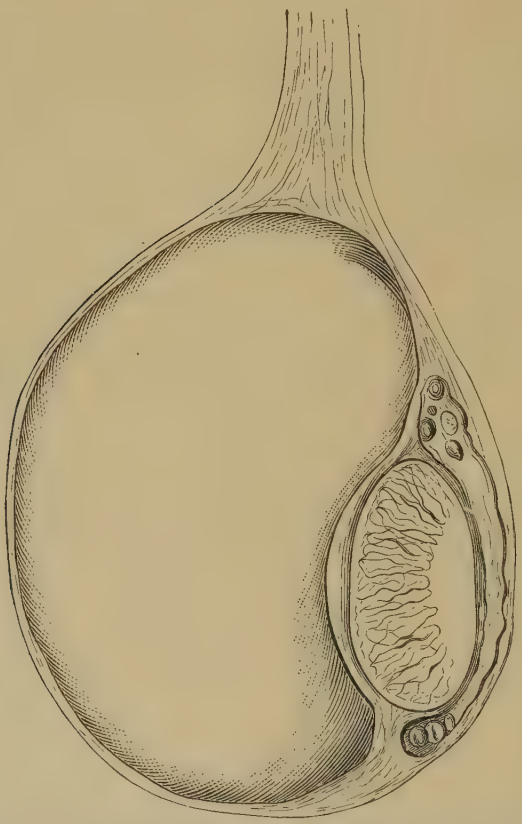
Pathological Anatomy.—The fluid which collects in the tunica vaginalis may vary in quantity up to 26 litres (quarts). (Bouisson.) It is usually clear, straw-colored, or slightly tinged with green. Sometimes it contains a few endothelial cells and white and red blood-corpuscles. In old hydroceles the fluid sometimes contains cholesterin crystals and spermatozoa, the latter due to rupture of retention-cysts in the epididymis. The fluid has a neutral reaction, a specific gravity of 1020, and contains from 4 to 5 per cent. of albumin. But it also contains a considerable quantity of fibrin in those cases of hydrocele following acute inflammation or traumatism. If the hydrocele has lasted a long time, the tunica vaginalis shows more or less well-marked changes, such as milky spots, yellowish or reddish-brown spots, and cylindrical or cord-like thickenings of the serosa, especially of that which covers the testis. In inflammatory cases there may be adhesions between the testis and epididymis, while calcifications are not uncommon in very old hydroceles. There may be pedicled or wholly free bodies, as mentioned above. The normal situation of the testicle may be altered by the various adhesions and thickenings of the tunica vaginalis. If the hydrocele is small, the testicle is usually situated in the posterior wall of the sac near its upper end. If the sac is still further distended by fluid, this distention takes place chiefly upward, so that the position of the testicle is relatively low (Fig. 329); but the distention upward is limited by the external abdominal ring, so that in very large hydroceles the position of the testicle is again relatively high.

Symptoms.—An ordinary hydrocele can scarcely be mistaken for anything else by any one who makes a proper examination. It develops without pain, and the patient seeks the advice of the surgeon either on account of its size or because its weight is uncomfortable; for when the fluid accumulates in sufficient quantity it drags upon the inguinal canal and spermatic cord. If a patient is obliged to stand and walk many hours, he is annoyed by the mass of the tumor which hangs between his legs. At other times the skin becomes excoriated, eczematous, etc. If the hydrocele is very large, it may so drag upon the skin of the penis as to prevent coitus and produce dribbling instead of a stream at micturition.

The first visible sign of hydrocele is a swelling of one side of the scrotum which as a usual thing gradually increases. It takes from six months to a year for the tumor to reach the size of a goose egg. Its shape is usually that of a pear with the smaller end directed upward. The skin which covers it is more or less stretched but not adherent. Sometimes the veins of the skin are dilated. The surface of the tumor itself is smooth, its consistence is more

or less tense and elastic, and in almost all cases fluctuation is present to a marked degree. The consistence of the tumor may vary in different portions. The thickness of the wall above described gives a sense of greater resistance, and there is frequently to be made out a ring between the lower broader portion of the tumor and the upper smaller portion. This ring, according to Kocher, marks the place

FIG. 329.



Sagittal section through a medium sized hydrocele in order to show the relation of the testicle and epididymis to the posterior wall of the sac. Notice that the outline of the whole tumor, taking sac and testicle together, is almost a perfect oval. The epididymis is somewhat elongated, especially in its upper portion. (Eberth.)

above which the vaginal process becomes obliterated in most persons, while in others it remains open for a variable distance above. There is also increased resistance posteriorly over the testis and epididymis. The position of the testis can often be determined by a sensitiveness on pressure. In smaller hydroceles and those in which the sac is not tense the testicle can be distinctly palpated. The tumor is sharply limited above, in contradistinction to solid growths, and

especially to hernia. Above it and within the inguinal canal there is nothing but the spermatic cord, although this is considerably thickened in cases of old and large hydrocele.

Among the characteristic symptoms of hydrocele is the translucency of the tumor, which can be demonstrated by stretching the skin tightly over the tumor and looking at it through a tube closely pressed against it, while an electric light or a candle is held on the opposite side of the tumor. It is necessary to press the tube against the skin with sufficient firmness to make a little groove so that no light shall enter the tube except such as comes through the tumor. Furthermore, the eye should be screened from the light of the candle so that it may the more readily recognize a faint and translucent light coming through the tube. On this account it is better to make the examination in a dark room. Translucency is much more marked in recent hydroceles than in those which have existed for a long time, and in which the walls have become thickened. There are rare cases of solid tumors of the testicle in which translucency is present. Bramann saw it in 2 cases of soft myxosarcoma.

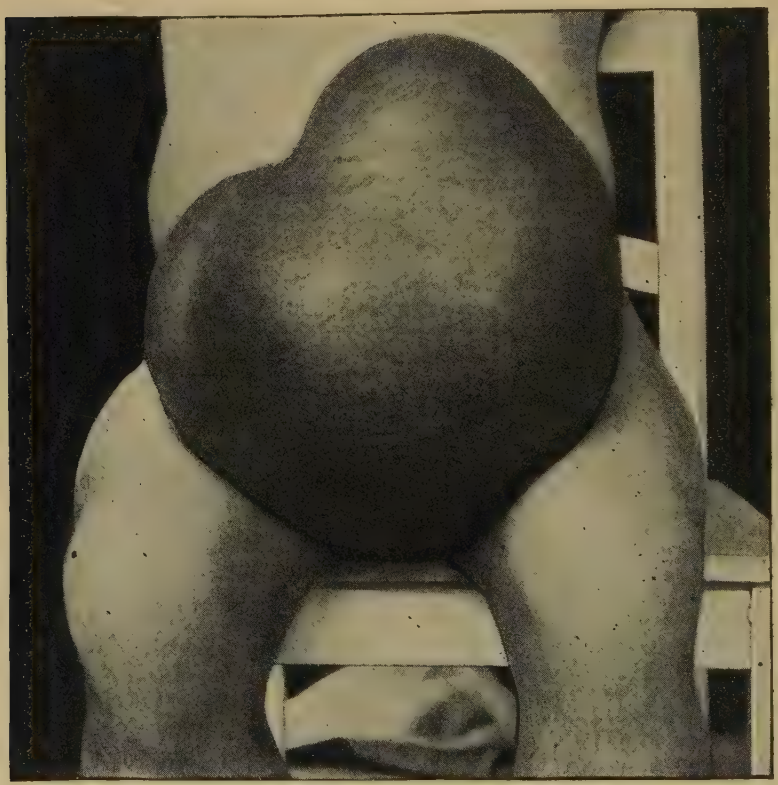
Diagnosis.—The diagnosis of hydrocele therefore depends upon the presence of an egg-shaped translucent tumor with a smooth surface, tense and elastic consistence, sharply differentiated above and obscuring the testis and epididymis, whose situation can usually be determined by pressure.

The tumor of a hydrocele increases steadily, though slowly. A very large hydrocele is often complicated with a hernia. Indeed, it may produce a hernia, for constant contraction upon the spermatic cord may drag the peritoneum into the inguinal canal and thus form a pocket for the entrance of omentum or intestine. The hernial sac may lie in contact through the upper end of the hydrocele so that the whole tumor may be mistaken for a hernia. (Fig. 330.)

It sometimes happens, and especially in children at or soon after birth, that a hydrocele develops whose upper end extends into the inguinal canal and communicates directly with the peritoneal cavity. This is, in other words, a vaginal process which is not closed, and which contains fluid derived from the peritoneal cavity or from the wall of the sac. Communication between the two is considerably narrowed at the internal inguinal ring, but in every case pressure upon one of these congenital hydroceles will cause the fluid to disappear into the peritoneal cavity. A congenital hydrocele is only possible in case descent of the testicle is delayed or obliteration of the vaginal process does not take place. Therefore it may extend to the bottom of the scrotum, or only part way; or, it may be situated in the various regions into which a testicle may erroneously wander. It gives rise to a cylindrical or ovoid tumor within whose sac is situated the testicle, while the fluid of the tumor disappears when the patient lies on his back or when pressure is made upon it.

A congenital hydrocele must be differentiated from a congenital hernia. The contents of both are reducible on pressure, but the return of the fluid to the peritoneal cavity is not accompanied by the intestinal gurgling which is so characteristic of congenital hernia. It cannot be mistaken for an omental hernia, at any rate, in the first year of life, for at this period the omentum is not sufficiently long to reach the inguinal canal.

FIG. 330.



Right hydrocele of twenty years' duration. Diagnosticated by many different surgeons as a hernia. It was complicated by a small inguinal hernia of both sides. The tumor was removed, together with the right testicle, and weighed 55½ pounds. (Bramann.)

Another variety of hydrocele reaches from the scrotum into the inguinal canal, where it lies in contact with the second sac between the peritoneum and the transversalis fascia, either in the vicinity of the internal abdominal ring or in the iliac fossa. This condition is spoken of as bilocular hydrocele (Fig. 331), and since its extra-abdominal and intra-abdominal sacs lie closely in contact pressure upon one causes the other to grow larger and more tense. A bilocular hydrocele is a result of faulty development in that the

vaginal process has become obliterated only at the internal abdominal ring, while the subsequent accumulation of fluid has produced an intra-abdominal diverticulum in one of the situations above described.

Fig. 331.

Bilocular hydrocele, partially intra-abdominal. Before operation.

It may also be due to a combination of the ordinary hydrocele with a hydrocele of the cord, the vaginal process becoming obliterated in spots. In some instances there is a communication between the two sacs of the bilocular hydrocele. (Fig. 332.)

Bilocular hydrocele should be suspected if the external tumor becomes smaller and softer when the patient lies down. In congenital hydrocele the fluid occasionally disappears. Bimanual examination will show the effect of pressure alternately made upon the extra- and intra-abdominal portions of the tumor. The two sacs may together hold as much as two or three litres (quarts) of fluid.

Prognosis.—Hydrocele has little effect upon the general nutrition of a patient, but if it is large it may interfere with his work and with the passage of urine. A double hydrocele is apt to suspend the secretion of semen, and thus to produce a sterility which may disappear with cure of the hydrocele. There is also a risk of ulceration of the skin, with possible infection, and the development of a hæmatocele as a result of traumatism.

injection. Volkmann was one of the first to advocate a free longitudinal incision for the evacuation of the fluid and a thorough examination of the whole cavity. The tunica vaginalis was then irrigated with a 3 per cent. carbolic solution and the cut edge of the skin was sutured to that of the tunica vaginalis, while the cavity of the latter was drained with gauze. In this manner he treated 163 patients with only a single recurrence.

The chief objection to an open operation is the necessity of keeping the patient in bed for a week, and the further fact that the wound does not entirely heal for two and a half weeks. There have also been noted cases of recurrence due apparently to the fact that the whole tunica vaginalis did not remain open until closed by granulations. Therefore in 1885 Bergmann suggested the still more radical treatment of removing the parietal portion of the tunica vaginalis. A longitudinal incision is made, opening the hydrocele, and the tunica vaginalis is pulled away from its outer coverings as far as the epididymis and then resected. This operation is easily performed unless previous injections or other inflammatory processes have caused the different layers to adhere intimately. Hemorrhage during the operation is slight if only the serous membrane is removed. Usually from two to six vessels must be tied. Any irregularities on the surface of the testicle or epididymis should be removed with a curette or scalpel; cysts of the epididymis should be opened or excised; any inflammatory foci should also be removed, and the testicle may then be replaced in the scrotum. No irritating antiseptics should be employed, and the wound may be closed without drainage. The dressing should be a firm one to prevent the formation of a hæmatoma; for, especially during vomiting, an effusion of blood may easily take place into the loose tissue. Such a hæmatoma is not a dangerous complication, but it is apt to leave some permanent thickening about the testicle. Twisting of the testicle may be avoided by including its fascial coverings in the first skin suture. Recovery should be without fever or pain. On the sixth day the suture is removed and the patient given a suspensory bandage, which he should wear for several weeks. In eight days he is ready to go to work unless the hydrocele is very large or has existed for a long time; if so, a few days more of treatment may be necessary.

The fear that removal of the tunica vaginalis might interfere with the nutrition and function of the testicle has proved groundless. Bramann has reported over 500 operations of this character upon patients who were subsequently examined and found to be perfectly well. In view of this fact the suggestion of Kocher and Juillard, to leave enough of the tunica to cover the testicle, has proved an unnecessary precaution, and one, moreover, which predisposes to recurrence of the trouble.

Jaboulay everts the sac of the hydrocele and thus effects a radical cure. This operation, as described by Delaure and Horand in 1897,

consists in longitudinal incision of the tunica vaginalis, and excision of a portion of it if it is large. The testicle is then pressed forward everting the whole of the tunica vaginalis. The everted sac is fixed behind the testicle by one or two sutures, so that everywhere its serous surface is in contact with the tunica dartos. (Fig. 333.) When the testicle is replaced within the scrotum, the skin-wound is sutured. At first glance this simple operation seems a most brilliant one; but experience has shown that in some cases the serous surface of the tunica continues to secrete fluid into the scrotal connective tissue, and that this fluid escapes more or less perfectly through the wound in the skin. In other cases eversion of the tunica vaginalis has obstructed the bloodvessels of the testicle, or even the vas deferens, thereby greatly interfering with the function of the testicle. In view of these facts the best operation for the radical cure of hydrocele is the resection of the parietal portion of the tunica vaginalis recommended by Bergmann. This operation may be performed with ether or cocaine.

FIG. 333.

Operation for hydrocele by eversion of the tunica vaginalis. (Hartmann.)

The use of the seton or electric puncture are methods of treatment of merely historical interest.

If the epididymis is inflamed as a result of traumatism or gonorrhœa, the patient should be directed to keep absolutely quiet as long as the testicle is tender, and to wear a well-fitting suspensory bandage for some weeks in order to prevent the development of a hydrocele.

Hæmatocele (Hemorrhagic Periorchitis). — Hæmatocele is a

chronic inflammatory process, the result of traumatic or spontaneous effusion of blood, and marked by the formation of connective tissue in the tunica vaginalis. The tunica under such conditions has a thickness of 1 to 1.5 cm. (0.4 to 0.6 inch), and presents the appearance of connective tissue arranged in concentric layers. There may be hemorrhages in its wall or on its surface. In recent cases the inner layers of the membrane may be easily pulled away from the outer. The examinations of Zangemeister show that the serosa is covered by a layer of granulation-tissue 0.5 to 1 mm. (0.3 inch) in thickness, which passes gradually into an outer layer of connective tissue poor in cells. A superficial endothelial layer is wanting. There is an abundant vascular development, so that it is difficult to say whether the inflammation is secondary to the hemorrhage or the hemorrhage secondary to a previous inflammation.

In long-standing cases there are firmer, almost cartilaginous masses in the wall of the sac, which sometimes project into this cavity and sometimes are flat and contain lime cells. These calcified plates may affect the whole of the tunica vaginalis excepting the portion which is attached to the testis and epididymis. In this manner a complete sheath may be formed 0.5 cm. (0.2 inch) in thickness.

Both the testis and the epididymis are affected by the overgrowth of subserous connective tissue, so that the epididymis may be wholly lost in the wall of the sac, while the testis still projects somewhat into its cavity. In other cases the new connective tissue grows over the surface of the testis as well as behind it, so that its projection into the cavity of the tunica vaginalis almost entirely disappears.

The content of a hæmatocele may be a serous or a serofibrinous or a hemorrhagic fluid; or pure blood; or an old, thickened, brownish blood.

Hæmatocele is especially likely to develop in an old case of hydrocele complicated by a traumatism. In some cases it has doubtless been produced by repeated puncture of a hydrocele followed by injection of iodine, etc. It is not necessary that the testicle itself be injured to bring about this result.

The hemorrhage may show itself at once in a sudden swelling within the scrotum; or the swelling may develop gradually in the course of weeks, corresponding to the occurrence of small repeated hemorrhages in the wall of the tunica vaginalis. In persons over forty years of age disease of the walls and vessels may favor such repeated hemorrhages.

As stated above, traumatism usually precedes a hæmatocele, and the first symptoms noticed are pain in the scrotum extending upward along the cord. If a tumor appears quickly, it will take the form of an egg and have a firm elastic consistence not everywhere uniform, but rarely giving a sense of fluctuation. The position of the testicle is essentially the same as it is in hydro-

cele. A characteristic sign of hæmatocele is the fact that the testicle compared with the rest of the tumor feels soft, whereas in hydrocele it is the firmest part of the tumor. If the contents of a hæmatocele are pure blood or if its wall is thickened or calcified, no translucency can be observed by the light-test.

The course of hæmatocele is a chronic one, often marked by a sudden increase in the size of the tumor and the occurrence of inflammatory symptoms due to exposure to cold, abdominal strain, violent coughing, etc. Sometimes an acute suppuration develops without apparent cause in any disease of the urinary vessels or elsewhere. It is supposed to be of hæmatogenous origin. Spontaneous recovery is not to be expected, and the function of the testicle suffers greatly as the tumor increases in size and its walls become thicker.

Treatment.—On account of the favorable course of the disease early operation is indicated. In recent cases the tunica should be split open, and freed from its contents and as many of the inner layers of the sac as can be readily pulled away. A portion of the tunica should be excised. This is far more difficult than in hydrocele, so that a complete excision of the parietal portion is rarely possible. The wound should be closed without drainage if there is no suppuration and the walls of the cavity can be brought into approximation. If stiffness or calcification of the walls prevents this, or if the testicle is already atrophic, or if there is a suppurative inflammation present, the whole tumor and testicle should be removed and the wound sutured or tamponed, according to circumstances.

Prophylactic treatment demands that any patient whose scrotum has been bruised in such a manner that bloodvessels are ruptured, and every patient whose tunica vaginalis is punctured for any purpose whatever, should keep absolutely quiet until the pain has disappeared, and then should go about with a well-fitting suspensory. Kocher and others reject absolutely the ambulant treatment of hydrocele by puncture, because of the possibility that hemorrhage may occur while a patient is walking about.

Proliferative Periorchitis.—There is a chronic inflammation of the tunica vaginalis marked by a new formation of connective tissue within the membrane and not upon its surface. In such cases the cavity of the tunica is slightly affected. There may be adhesions between opposing surfaces. The tunica albuginea of the testicle is also thickened and the connective-tissue growth extends into the organ itself. In general, the disease progresses without painful symptoms, and may easily be mistaken for orchitis, or syphilis, or tuberculosis of the testicle.

Calcification of some portion of the tunica vaginalis is not uncommon. This disease does not threaten the life of the individual, but leads sooner or later to loss of function of the affected testicle. If, by reason of its weight, the testicle is troublesome, it should be removed.

Adhesive Periorchitis.—In any chronic inflammation of the testicle, and very often following puncture and injection of iodine, fibrinous inflammation of the tunica vaginalis is produced, as a result of which membranous or cord-like adhesions are set up between the opposing serous surfaces. Kocher believes that such adhesions interfere with the function of the testicle, and this is to him an additional objection to treatment by aspiration and injection of iodine.

Hydrocele of the Cord (Serous Perispermatitis).—Hydrocele may develop in an unobliterated portion of the vaginal process, showing itself either within or outside the inguinal canal. The sac which contains the fluid may or may not connect with the general peritoneal cavity. If it does so, it is called a communicating or congenital hydrocele, as described above. Or, if it reaches nearly to the testicle, it may exist largely with hydrocele of the tunica vaginalis, giving what is known as bilocular hydrocele, as already described.

In counterdistinction to the usual form of hydrocele, hydrocele of the cord occurs chiefly in children, and those adults who suffer from it have usually done so since childhood. It may follow contusion, strain, the wearing of a truss, etc., but it is less often the result of inflammation than is hydrocele of the tunica vaginalis.

Symptoms.—The chief symptom is the formation of a tumor as large as a walnut or larger, of an oval or rounded form, smooth surface, and tense or firm consistence. Such a tumor is invariably translucent. It is always distinct from the testicle. If the tumor is small, it is easily moved about, and it can often be pushed up into the inguinal canal. It can usually be dragged downward by a pull upon the spermatic cord. It is more tense than a hernia. (Figs. 334 and 335.)

Hydrocele of the cord must be differentiated from spermatocele, which is never movable upon the epididymis, and also from a collection of fluid in a hernial sac, which does not usually descend when the spermatic cord is dragged upon.

The sac contains a clear fluid which may be tinged with blood if the injury was severe. Pain is absent if the tumor is small unless it is caught in the external ring. If the tumor is large, there is a sense of pressure and pain which may extend downward into the scrotum or upward into the iliac fossa.

Treatment.—Hydrocele of the cord should be treated in accordance with the principles given for a hydrocele of the tunica vaginalis. Puncture and injection of iodine are inadvisable on account of the possible close approximation of the sac with the peritoneal cavity. The best treatment is excision and removal of the sac with its contents, if possible. In recent cases this operation is not difficult. In children a single puncture may effect a cure.

Hæmatocele of the Cord (Hemorrhagic Perispermatitis).—This condition is usually preceded by hydrocele. An inflammatory

process may be grafted upon a hæmatoma due to traumatism, and in this manner layers of fibrin and new connective tissue be formed, as was described under the heading Hydrocele. Kocher and others

FIG. 334.

Diffuse hydrocele of the cord. (Taylor.)

FIG. 335.

Encysted hydrocele of the cord. (Taylor.)

have reported cases of hæmatocele following puncture. The shape and position of hæmatocele of the cord are similar to those of hydrocele of the cord. It is, however, somewhat firmer, more tender, and rarely translucent. The wall not infrequently calcifies. In recent

cases there are often found small hæmatomata between the concentric layers of connective tissue, while in injury of the sac there are new-formed fibrinous deposits.

Prognosis.—The prognosis of this trouble is more favorable than that of a hæmatocele of the testicle for the reason that the testis and epididymis are not disturbed by it. There is always a possibility of acute inflammation or of further growth.

Treatment.—In the extra-inguinal form of hæmatocele the tumor should be excised either totally, or, if the cord is not easily separated from it, a part of it may be left. If a hæmatocele is situated within the inguinal canal, or peritoneally, the anterior abdominal wall must be split up, the contents of the sac evacuated, so much of the sac as possible removed, and the wound closed by suture.

Multilocular Hydrocele.—Either the tunica vaginalis or the partly obliterated vaginal process along the cord may be the seat of numerous cystic dilatations which lie close together or are possibly invaginated one into the other. A large hydrocele of the testicle may contain a few small cysts of the upper end of the epididymis. These are almost invariably spermatoceles. Sometimes multilocular hydrocele is due to adhesive inflammation of the tunica vaginalis which has divided its cavity into several portions.

Echinococcus may form multilocular cysts along the spermatic cord.

In other cases cysts are found in the upper end of the epididymis, which are said to be due to the remains of Müller's duct, while others in connection with the vas deferens are said to have developed in the Wolffian body. A cystic lymphangioma may also occur in this region.

Treatment.—The best treatment of multilocular hydrocele is exposure and removal of the different cysts. Treatment by puncture and injection is unsatisfactory for the reasons given under "Hydrocele of the Testicle," and also because it is difficult or impossible to aspirate and inject every cyst.

Diffuse Hydrocele.—Some writers include under this term hydrocele of the cord as well as communicating hydrocele, bilocular hydrocele, and multilocular hydrocele. The better plan, however, is to restrict the term to those cases in which there is a diffuse œdema of the cellular tissue of the cord, usually due to rupture of a spermatocele or of a hydrocele.

Complications of Hydrocele and Hæmatocele.—It has already been stated that hydrocele and spermatocele often coexist. The combination with hernia is still more frequent, the hernial sac either reaching to that of the hydrocele or developing behind the hydrocele; or in front of and below the hydrocele. This last condition is especially seen in hydrocele of the cord combined with hernia. Sometimes the hernial sac invaginates the hydrocele sac for a little distance, giving a co-called encysted hernia. In some

cases the lower portion of the tunica vaginalis is the seat of the hydrocele, while its upper portion is open, thus forming a hernial sac, but without contents. Such a sac is really an empty hernial sac in which acute or chronic inflammation has produced a hydrocele.

TUMORS OF THE MEMBRANES.

Primary tumors of the membranes are rare, with the exception of the cystic tumors above described as developing in the remains of Müller's duct and of the Wolffian body.

Lipoma.—A lipoma may be found between the serous and outer layers of the membranes of the cord or testicle, corresponding to a lipoma in the subperitoneal fatty tissue. Such a lipoma may reach from the inguinal canal to the testicle. It may be so soft as to be mistaken for a varicocele; or so hard that it is mistaken for an irreducible omental hernia. Such a tumor may cause pain by pressure upon the cord, and may interfere with the nutrition of the testicle. It should therefore be removed.

Sometimes a diffuse lipoma is found which infiltrates the tissues of the cord itself. Such a tumor is likely to recur after it is removed.

Fibroma.—Fibroma occurs as a circumscribed tumor of the cord, or as a diffuse thickening of the membranes. Such tumors are likely to undergo sarcomatous degeneration, and should therefore be removed.

Sarcoma.—A sarcoma may develop secondarily to hæmatocele, or it may develop in a benign tumor. It forms a circumscribed mass, especially in the course of the spermatic cord, which grows rapidly and soon reaches the testicle, or which grows up into the inguinal canal. There is also a diffuse sarcoma of the membranes which is made up of harder portions and softer intervening portions, so that it is apt to be mistaken for a hydrocele, from which it is distinguished by a very rapid growth and a lobular surface. Removal of a sarcoma is to be combined with castration.

Varicocele.—An abnormal dilatation or elongation of the veins of the spermatic cord, corresponding to the varicosity of the veins of the lower extremities, is spoken of as a varicocele. The trouble is a common one, and is most apt to occur in early adult life. Its frequency is variously estimated at from 1 to 2 per cent. Curling found that varicocele exists on the left side alone in 86.5 per cent. of the cases, on the right side alone in 6.1 per cent., and on both sides in 7.4 per cent. This striking difference is explained by the termination of the left spermatic vein in the renal vein at a right angle, by which the flow of its blood is somewhat interfered with. The right spermatic vein empties at an acute angle into the vena cava, so that the two streams are nearly parallel, while the pressure in the vena cava is distinctly less than that in the left inguinal vein. The left testicle hangs lower than the right, so that

gravity acts with a little more force upon the blood in the left cord while the left cremaster muscle is more stretched and less powerful in its action upon the veins than that of the right side.

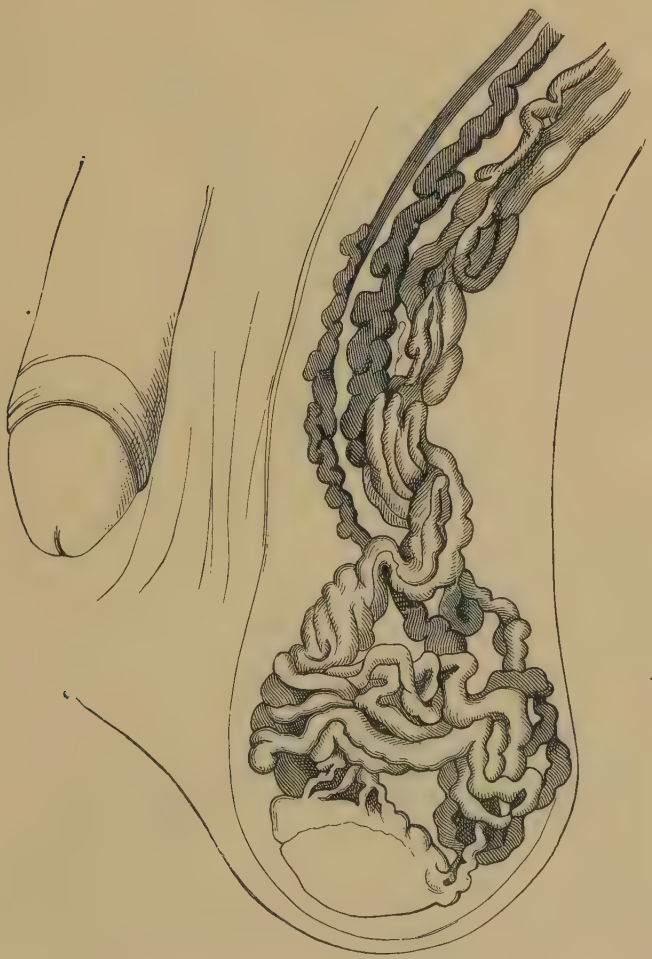
Etiology.—The dilatation and elongation of the veins is due either to increased blood-pressure or to a weakening of the walls of the veins. Blood-pressure in the veins of the cord is increased on account of the increased activity of the testicle in a young adult. When dilatation has once begun, it is favored by various causes. Thus both the artery and veins are without branches for a considerable distance. Furthermore, the course of the spermatic vein through the inguinal canal exposes it to pressure from inflammatory exudates, tumors, etc. The force of gravity acts chiefly when the patient is upright, so that varicocele is usually found in those who stand or walk a great deal, and in slender persons rather than in those who are stout. In some cases congenital flabbiness of the scrotum and abnormal thinness of the wall of the veins, etc., favor venous dilatation. Fecal obstruction in the sigmoid flexure and straining at stool due to constipation, also produce engorgement of the spermatic veins and their branches.

Pathology.—In many cases a varicocele develops gradually, in others quickly. The nature of the pathological process makes it improbable that it follows a single severe strain or blow, as the histories given by some patients would indicate. These pathological changes consist in a great dilatation of all the branches of the spermatic plexus. The individual veins are larger and more tortuous, and both the adventitia and intima are thickened, while the muscular coat is weaker than normal, and in certain places there are local dilatations of the vein. These changes are most marked in the veins nearest the testicle, and this organ often assumes a nearly horizontal position. (Fig. 336.) The veins in the testis itself may also become varicose. The varicosity may extend upward as far as the inguinal canal, but rarely enters it. Bennett divides these cases into three groups: first, those in which there is a long diffuse swelling extending from the ring to the testicle and causing few symptoms; second, those cases in which there is a rounded swelling close to the testicle which might easily be mistaken for a tumor of the testicle —this condition is most common about the age of puberty; in the third group of cases the upper portion of the plexus is most affected, so that the condition suggests hernia, especially as an impulse is felt on coughing or straining. For a similar reason a dilated saphenous vein at its termination in the femoral has many times been mistaken for a femoral hernia. The tortuous course of the dilated veins leads sometimes to thrombosis, and occasionally to the formation of phleboliths—slender oval bodies not larger than grains of rice.

Symptoms.—A varicocele may develop without pain, but if the veins dilate rapidly and especially during hot weather, or after severe exercise, there is more or less burning in the scrotum and pain in

the groin, more marked when the patient stands. Pain may also extend into the iliac fossa and lumbar region or down the thigh. Sometimes it is neuralgic in character, especially during sexual excitement. Sexual desire is much diminished, either on account of fear of this pain, or on account of the atrophy of the testicle which

FIG. 336.



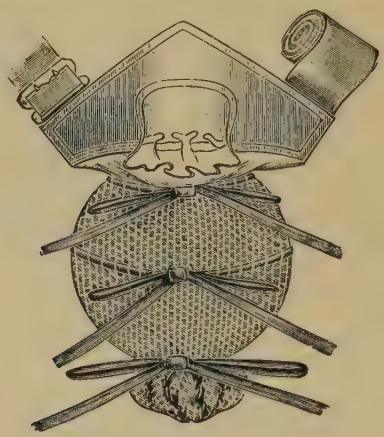
A dissection of a well-marked varicocele. Notice the almost horizontal position of the testicle, with the epididymis above, its head directed forward.

usually follows the development of a well-marked varicocele. There is often increased perspiration from the skin overlying the affected parts.

On examination the left side of the scrotum will be found elongated and filled with a mass which is larger at the bottom than at the top. If the skin is thin, the bluish color of the dilated veins

may be seen through it. Sometimes the veins in the skin of the penis are also dilated and tortuous. The somewhat atrophic testicle is easily recognized at the lower end of the tumor. In the upper portion of the tumor the freely movable tortuous veins which collapse on the slighest pressure have been compared to a bag of earthworms. The vas deferens, a solid string in contrast to the veins,

Fig. 337.

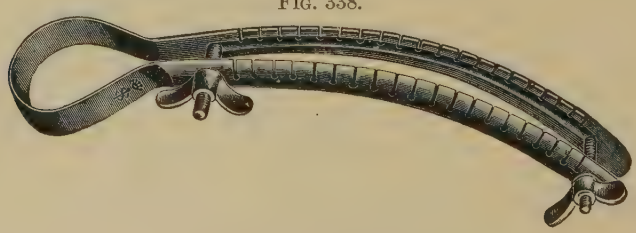


Miliano's varicocele compressor.

can usually be felt posteriorly. When the patient lies down the tumor disappears in slight cases, while in marked instances the mass of knotted empty veins can still be felt.

Varicocele must be differentiated from inguinal hernia, from lipoma, and from hydrocele. The diagnosis is made easier by the fact that varicocele rarely occurs in children and old people.

Fig. 338.



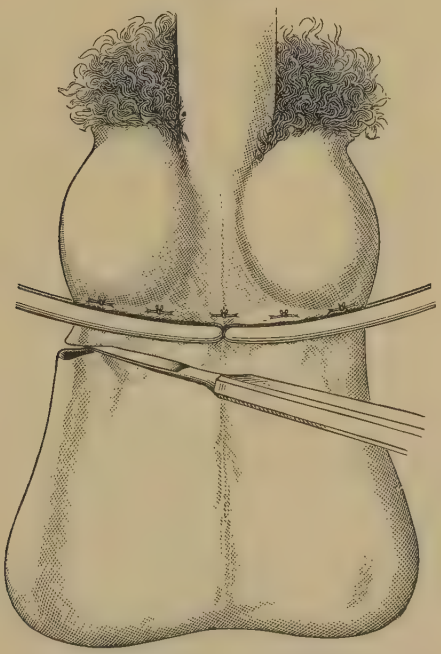
Varicocele clamp. (King.)

Without doubt varicocele often terminates in spontaneous recovery after the period of sexual activity. Its symptoms in younger persons may be much reduced by the avoidance of sexual excess. A varicocele rarely undergoes acute or suppurative inflammation.

Treatment.—In view of the spontaneous cure which sometimes occurs the first treatment of varicocele should be prophylactic. When the symptoms are more serious and atrophy of the testicle is threat-

ened, an operation should be performed. Prophylaxis consists in regular exercises and avoidance of sexual excess, local cold baths and douches, and the use of a well-fitting suspensory bandage. Nélaton recommended that the lower portion of the scrotum be drawn through a rubber ring so that the testicles might be constantly elevated. Miliano elevated and compressed the contents of the scrotum by means of a special form of suspensory bandage. (Fig. 337.) Astley Cooper excised the lower portion of the scrotum. (Figs. 338, 339, and 340.) But this measure is often followed by a recurrence of the trouble. Elastic pressure by means of a specially constructed

Fig. 339.



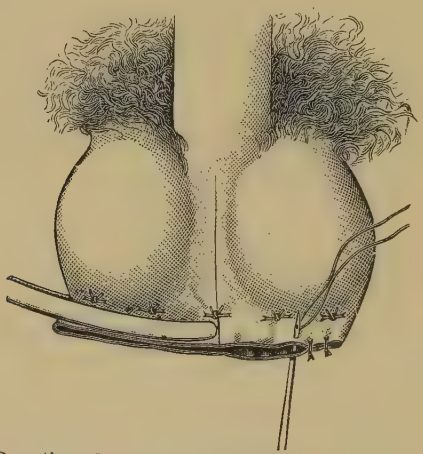
Resection of scrotum for varicocele. (Hartmann.)

truss, injection of alcohol and other irritating substances, the use of the galvanocautery, percutaneous ligation, etc., are methods of treatment no longer in vogue.

If the varicocele is large or produces serious symptoms, the veins should be ligated and resected through an incision parallel to the spermatic cord. The dilated plexus of the veins is dissected free from the upper end of the testicle to the external inguinal ring, if necessary. The vas deferens and spermatic artery are isolated before any ligatures are applied. The mass of veins is next ligated above and below, and the portions between the ligatures resected. (Fig. 341.) The upper and lower stumps are then tied or sewed

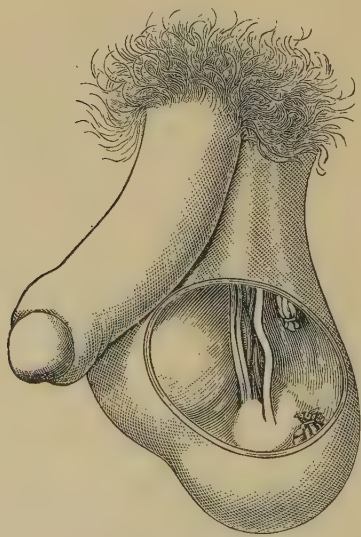
together so that the testicle may be lifted. If the scrotum is much elongated, it may be shortened by suturing the longitudinal incision transversely. At the close of the operation the wound is covered with an aseptic bandage and the stitches removed a week later. The

FIG. 340.



Resection of scrotum for varicocele. (Hartmann.)

FIG. 341.



Resection of the varicose veins together with the skin of the scrotum for varicocele. (Hartmann.)

patient should remain two weeks in bed in order to avoid the formation of emboli. If the testicle is atrophied, the patient's attention should be called to it before the operation, as it is much more noticeable after the mass of veins has been removed.

CHAPTER XXXVI.

INJURIES AND DISEASES OF THE TESTICLE.

CONTUSIONS OF THE TESTICLE.

CONTUSIONS of the testis and epididymis may result from a blow or fall upon the scrotum. On account of the sensitiveness of the testicle the pain from such an injury may be intense, even producing collapse or sudden death.

A microscopical examination will show the presence of smaller and larger hemorrhages in the substance of the testis and epididymis. If the violence is more severe, the tunica albuginea may rupture.

Symptoms and Diagnosis.—The scrotum is more or less swollen and suffused with blood, although the discoloration may not appear for some days. Palpation shows that the affected testicle is abnormally tender and enlarged. In acute cases it is impossible to say whether the testis or epididymis is more affected. Later, when the œdema subsides, the exact situation of the hemorrhage can be made out. The epididymis is more often affected than the testis, and usually the swelling is most marked in its lowest portion. The vas deferens may be quite unaffected. Usually only one testicle is affected.

Treatment.—Pain decreases rapidly if the patient is put to bed and an ice-bag applied to the elevated scrotum. The swelling disappears less rapidly. Perhaps after several weeks have elapsed there may still be felt a nodular connective-tissue scar. Sometimes the traumatism is followed by inflammation, sometimes by atrophy of the testicle.

DISLOCATION OF THE TESTICLE.

One or both testicles may be dislocated by traumatism and driven out of the scrotum into those positions in which an undescended testis comes to lie, namely, in the vicinity of the external ring (luxatio cruralis), under the skin of the abdomen (luxatio abdominalis), or into the perineum (luxatio perinealis), or into the inguinal canal (luxatio inguinalis). The absence of the testicle from the scrotum and the presence of a tender mass in one of the situations mentioned are sufficient to make the diagnosis. In most cases the testicle can be replaced without an incision. If, when the skin has been cut through, the testicle cannot be replaced, it should be removed, as otherwise it will atrophy.

WOUNDS OF THE TESTICLE.

Punctured wounds of the testicle are often made with a trocar. For the most part they heal without complication. If suppuration follows in the testis or epididymis, the abscess should be incised and drained. Even a short incised wound of the testicle is followed by prolapse of the seminal tubules through the cut in the tunica albuginea. These prolapsed tubules will become necrotic, and others may prolapse, so that such a wound should be at once sutured. Primary union is the result in non-infective cases. Gunshot-wounds of the testicle destroy extensively its parenchyma and even lead to gangrene; for this reason castration is recommended if the injury is severe.

ACUTE INFLAMMATION OF THE TESTIS AND EPIDIDYMIS.

Epididymitis.—Acute inflammation of the epididymis is commoner than that of the testis, and for the most part is due to one of three causes: it may follow direct traumatism; more often there is an extension of infection from the urethra along the vas deferens to the epididymis; while in a few cases inflammation reaches the epididymis through the bloodvessels from some other portion of the body.

Traumatic epididymitis may follow a fall or a blow upon the testicle, especially if the patient has previously had gonorrhœa. It may also follow an indirect injury, such as a strain due to lifting heavy weights, blowing a horn, or jumping. It has been suggested in such cases that the testicle is suddenly jerked against the external abdominal ring. Urethral epididymitis may develop after wounds of the urethra due to the passage of a renal calculus, or some instrument, or to some operation upon the urethra such as urethrotomy. It frequently occurs in persons with urethral stricture or hypertrophy of the prostate who are obliged to catheterize themselves. In all these cases the urethral wound becomes infected by bacteria introduced into the urethra from without or by such as were in the urethra at the time of injury.

The large majority of cases of epididymitis are due to infection with gonococcus. This complication of gonorrhœa has been estimated to occur in from 6 to 27 per cent. of all cases. It develops in the second or third week of a gonorrhœa, often as a result of some muscular effort, such as dancing or riding; or it may follow injudicious instrumental treatment of the urethra. In many cases, however, no special cause for it can be assigned.

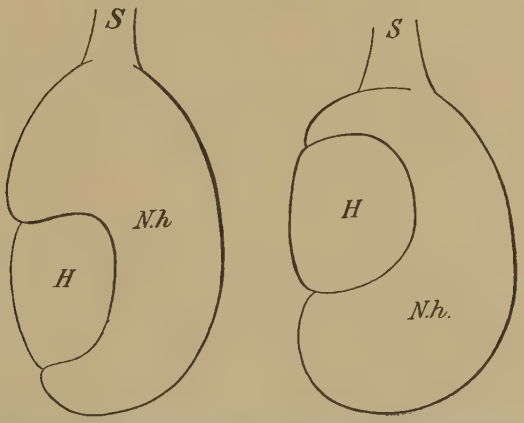
Metastatic epididymitis is extremely rare. The testis is more often involved in an inflammation of this character, which is therefore described in connection with it.

Symptoms.—Acute epididymitis begins with a severe pain in the

testicle and groin, which may extend to the thigh and into the back; fever may or may not be present. The general condition of the patient may be seriously affected. Soon tenderness on pressure and swelling, especially in the epididymis, are noticed, while a serous or plastic exudate forms in the tunica vaginalis. The swelling often extends to the skin, so that in a few days the affected half of the scrotum may be as large as the fist.

It is usually possible to differentiate the testis and epididymis by palpation. (Fig. 342.) If, however, the condition is complicated by acute periorchitis, the outlines of the inflamed epididymis are less distinct.

FIG. 342.



Illustrating the relations of the epididymis and testis in acute epididymitis. In the first drawing the head of the epididymis is chiefly affected, and in the second drawing, the tail. *H*, testis; *Nh*, epididymis; *S*, spermatic cord.

Diagnosis.—The existence at the same time of a purulent urethral discharge and an acute swelling of the testicle render diagnosis of urethral epididymitis easy. In most cases the scrotum is red and tender and its folds are partly obliterated. In acute orchitis the scrotum is also stretched, but not so acutely swollen. Furthermore, pain in acute orchitis is due to stretching of the tunica albuginea, and is not affected by changes in position. In acute epididymitis pain is chiefly due to tension upon the spermatic cord, so that it is relieved when the patient elevates the testicle with his hand or lies upon the back. Tuberculosis of the epididymis begins mildly and runs a slow course without acute inflammatory symptoms.

In acute epididymitis the seminal tubules contain a mucopurulent exudate while the epithelial and subepithelial layers are infiltrated with leukocytes. Infiltrate and exudate, and possibly small abscesses, are found in the interstitial tissue.

The course of the inflammation is from one to two weeks. Swelling and tenderness gradually subside and the scrotum resumes its

normal folded appearance. More or less thickening of the epididymis may persist for some months. Sometimes as one testicle recovers the other one becomes inflamed. In rare cases the inflammation, whether traumatic or urethral in origin, lasts until the tissue breaks down and an abscess is formed, ushered in by chills and high fever.

The spermatic cord may be inflamed at the same time as the epididymis or later. It can then be recognized as a hard, tender, swollen cord which gradually resumes its normal conditions under the influence of rest, elevation of the scrotum, etc.

Treatment.—In every case of gonorrhœa, or other disease of the urethra, prostate, or bladder, the patient should be given a well-fitting suspensory bandage, and be warned against muscular over-exertion and sexual excess. If the epididymis becomes inflamed the patient should go to bed, elevate the scrotum, and apply to it an ice-bag or cold wet compresses. Under these applications the pain soon subsides, and in a few days the acute inflammatory symptoms also disappear. An adhesive plaster bandage may then be applied and the testicle compressed with benefit. Fricke's directions for this dressing are as follows:

"The surgeon seizes the affected testicle with the left hand and separates it as far as possible from its fellow. A strip of plaster as wide as the finger is then bound around the cord above the testicle; from this strip numerous other strips are applied longitudinally, each one crossing the testicle at its lowest point and reaching up to the circular strip on the opposite side. Enough such strips are applied to enclose the testicle completely in a plaster basket. The longitudinal strips are held in place by another circular strip above the testicle. As the swelling in the testicle disappears the plaster will become loose and must be freshly applied."

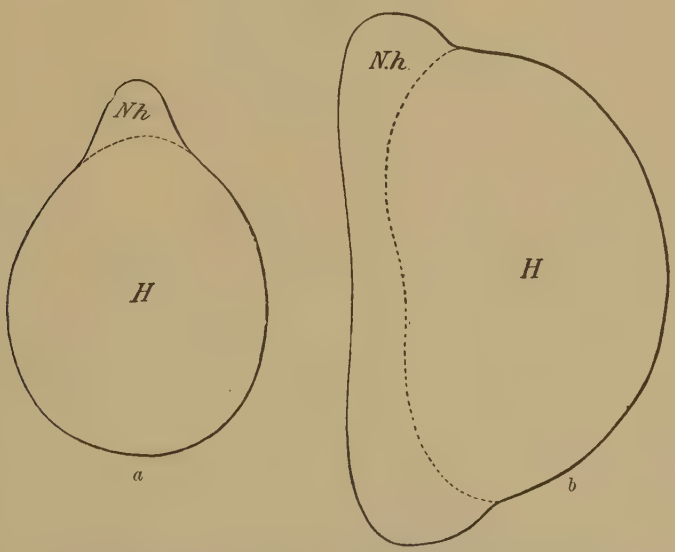
In mild cases the patient need not go to bed as sufficient rest can be obtained by a well-fitting suspensory, by which, if necessary, a moist compress may be kept over the testicle. If there is a great effusion of fluid into the tunica vaginalis, the pain may be so severe as to require puncture. If the swelling and pain keep up for two or three weeks with more or less fever, abscess is to be suspected. Its treatment is incision and drainage.

Prognosis.—Epididymitis is not a fatal disease, but it often acts injuriously upon the testicle. Gonorrhœal epididymitis particularly is followed by cicatricial thickenings in the tail of the epididymis, which interfere with the flow of semen. Liégois examined 28 patients who had suffered from bilateral epididymitis, and found spermatoza in only 7 of them. Other writers say that the absence of spermatozoa after epididymitis is only a temporary condition, lasting perhaps not more than six months. Benzler states that 77 of 100 soldiers who were known to have double epididymitis later became parents.

Chronic epididymitis usually starts in an acute attack, the

exudate which accompanies the latter going on to connective-tissue formation. As a result there may be nodular thickenings in which lime salts may be deposited. The contraction of the connective tissue may produce complete obliteration of the vas deferens with the formation of retention-cysts. Or, abscesses may develop which rupture and leave fistulas. Any such abscesses should therefore be opened and drained and existing fistulous tracts should be excised. If abscesses are scattered through the whole testicle, castration is advisable. If the abscesses are confined to the epididymis, this part of the testicle may be split open and the abscesses evacuated and their membranes destroyed. If the epididymitis is of urethral origin, complete cure of the epididymitis should not be attempted until the urethral inflammation is recovered from.

FIG. 343.



Showing the relations of the testis and epididymis in acute orchitis; *H*, testis; *Nh*, epididymis; *a*, sagittal section; *b*, horizontal section. (Kocher.)

Orchitis.—Acute inflammation of the testis, or orchitis, as it is called, may follow the same causes as epididymitis, namely, traumatism, urethritis, and suppurative processes elsewhere in the body.

Traumatic orchitis is spoken of on page 694.

Urethral orchitis may occur on one or both sides as the result of stricture, prostatic hypertrophy, disease of the bladder, or after operation upon the urethra. It seldom follows acute gonorrhœa, although in persons who have several times suffered from gonorrhœa orchitis may develop. In such cases the inflammation is due to mixed infection, and not to infection by gonococcus alone.

Inflammation of the testicle due to metastasis, however, invari-

ably involves the testis rather than the epididymis. Such metastatic orchitis is often seen as a complication of mumps in certain epidemics of this disease. It also occurs in connection with typhoid fever, smallpox, acute rheumatism, influenza, pneumonia, and malaria.

Symptoms.—Acute orchitis begins with fever and even more pain than epididymitis since the testis is surrounded by the firm tunica albuginea. Nevertheless the swelling may take place so rapidly that in one or two days the testis becomes double its normal size, presenting itself as an oval tense tumor with smooth surfaces and uniform consistence, which is very tender on pressure and gives a sense of fluctuation. The position of the epididymis is characteristic. By contrast with the swollen testis it feels like a small rounded bladder placed posteriorly. (Fig. 343.)

Diagnosis.—If the epididymis cannot be felt, the diagnosis is less easy. The case may be one of simple periorchitis, or orchitis and periorchitis combined. If so, aspiration of the fluid will enable the surgeon to feel the testis and epididymis. In orchitis the scrotum is stretched and its veins are prominent, but there is no such œdematous swelling as exists in epididymitis and periorchitis. Frequently the spermatic cord is swollen and tender. The vas deferens itself may or may not be affected.

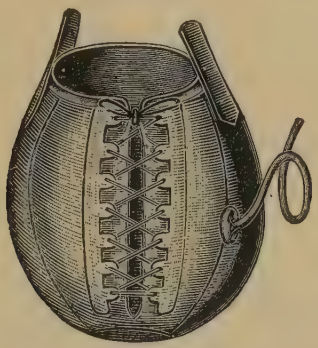
Progress of the Disease.—Slight traumatic and urethral attacks of orchitis usually disappear entirely in a few weeks. Metastatic orchitis after mumps, rheumatism, and malaria rarely leads to formation of an abscess, but frequently of atrophy of the testicle. If the orchitis is due to chronic inflammation of the urethra, prostate, or bladder, or is secondary to typhoid fever, influenza, or pneumonia, it may go on to suppuration or even gangrene of the testicle. If so, and the testicle disintegrates, there will be intense fever and often septic symptoms. In a few cases the inflammation has been observed to follow up the spermatic cord and lead to fatal peritonitis.

The ordinary acute orchitis lasts from two to four weeks, and then disappears entirely, although in certain cases, as above mentioned, it may be followed by atrophy of the testis.

Treatment.—Rest of the parts should be secured by putting the patient to bed, elevating the scrotum and applying cold compresses. In some instances the adhesive strapping described in the treatment of epididymitis is efficacious, but in most cases pressure increases the pain. (Fig. 344.) If an abscess is formed, it should be opened, but König advises the postponement of incision in cases of numerous small abscesses until they have had time to join into one, as an early incision is no guarantee against gangrene or atrophy. Incision may be followed by protrusion of the seminal tubules, which become necrotic and give rise to the formation of a spongy tumor made up of granulations, a condition often requiring a long time for its cure.

Payer mentions a case of orchitis of unknown origin going on to suppuration, in which incision and drainage of the affected testis were followed by prolapse of the seminal tubules and gangrene, so that castration was necessary. Six months later the patient suffered from a chill and intense pain in the remaining testicle. Palliative treatment was unsuccessful; the testicle was treated by incision. The

FIG. 344.



Orchitis compressor. (Hawes.)

epididymis was comparatively normal, but the testis was intensely swollen and discolored. It was incised and a great quantity of thin yellowish pus escaped from it, although no abscess cavity was discoverable. In view of the previous loss of the other testicle it was decided to irrigate and suture this one, a method of treatment which brought about a speedy cure without atrophy or loss of function of the organ, as shown by the persistence of active spermatozoa in the seminal fluid.

Primary suture of the tunica albuginea will prevent prolapse of the seminal tubules, and will apparently save the patient from gangrene as well as from atrophy of the organ.

Rheumatic orchitis should be treated by the administration of salicylates; malarial orchitis by the administration of quinine.

Chronic Orchitis.—An acute inflammation of the testis may pass gradually into a chronic inflammation, which may be either diffuse with infiltration of the interstitial tissue, or circumscribed with formation of abscesses. Diffuse orchitis is a rare condition in which the testicle may become as large as a child's head, making castration necessary. Incision of the abscesses in the chronic form of orchitis does not, unfortunately, always terminate the process.

TUBERCULOSIS OF THE TESTICLE.

Tuberculosis of the testicle is common in early adult life, and it may appear also in childhood as well as in later adult life. The patient first notices one or more hard nodules in the head or tail

of the epididymis. These may or may not be sensitive. They frequently grow within four to eight weeks to the size of a hazel-nut, and may then soften and discharge their contents through one or more sluggish fistulas. At this stage the vas deferens is usually affected, being tender and infiltrated. Within a few months the disease extends as far as the testis, and there is a risk of its developing in the other testicle as well. Dürr's statistics show that the second testicle became affected in two-thirds of 63 cases. The disease usually runs its course with little or no fever. Indeed some of the patients affected appear to be in robust health, but the large majority show some emaciation and anæmia, and a careful examination will show the presence of tubercles in the lungs, bones, or lymph-glands. Reclus, who examined the bodies of thirty persons who suffered from tuberculosis of the testicle, found pulmonary lesions in twenty of them. There are often complicating nodules of tuberculosis in the prostate, bladder, seminal vesicles, ureters, or kidneys.

Pathological Anatomy.—In its early stages a tuberculous nodule in the epididymis shows on cross-section a grayish-red shiny tissue in which are embedded numerous convoluted tubules filled with cheesy yellow exudate. Tuberculous nodules beginning in the epithelium of the walls of the tubules unite as they spread, and then caseation takes place in their centres, destroying the normal structure of the epididymis, and forming abscess cavities. In this manner the whole epididymis may be destroyed. There are usually one or more nodules in the vas deferens which start in the mucosa and muscular layers and then ulcerate and fill the lumen of the vas deferens with cheesy pus. On palpation the vas deferens may be uniformly thickened, or the separate nodules may be felt, which, if they are numerous, merit the comparison of pearls on a string.

The tubercle bacilli may pass up the seminal tubules and form new nodules in their walls, or they may pass through the lymph-channels and form nodules in the parenchyma of the testis, in the neighborhood of the tubules. Here, too, the process soon goes on to caseation and abscess formation. According to König, the testis is usually filled with miliary nodules at the time when the epididymis is pretty generally destroyed. (Fig. 345.)

In rare cases of primary tuberculosis of the testis one or more nodules exist which tend, like all such nodules, to caseation and abscess formation.

Tuberculosis when in the testis or epididymis tends soon to extend into the neighboring tissues. The tunica vaginalis is affected, and as a result it becomes filled with a serous exudate producing a so-called spermatic hydrocele. The abscesses finally break through the skin, forming constantly discharging fistulas. If such a fistula leads to the testis, a tuberculous fungoid tumor may result, which is

a mass composed of spongy granulations from the tunica albuginea together with the caseous seminal tubules.

Etiology.—It is beyond doubt that tuberculosis of the testicle may occur in otherwise healthy persons. In such cases, according to Kocher, tubercle bacilli exist in the testicle at the time of birth and first develop after some traumatism. Others believe that there is some hidden focus of tuberculosis, perhaps in a bronchial gland,

FIG. 345.

Tuberculosis of the testicle; caseation of the epididymis; miliary nodules of the testis.

from which the bacilli make their way into the testicle. This theory seems more reasonable since it is well known that tuberculosis of the testicle is frequently secondary to tuberculosis of the lungs, bones, and glands. A third possible method of infection is by means of the urinary tract. It was formerly believed that a testicle might be infected during coitus, but this idea is now abandoned. It is at present well recognized that there is an ascending infection from the testicle through the vas deferens, prostate, seminal vesicle, urethra,

bladder, and ureter to the kidney. Is it not then possible that infection may also descend from the kidney to the testicle?

These interesting questions cannot be settled from the results of pathological examinations hitherto made. Kocher believes in the descending theory because in many cases the vas deferens is caseous at the time when the bloodvessels of the spermatic cord are either wholly free from disease or only slightly affected. Infiltration of the capillaries of the cord indicates that the disease has proceeded by the lymph-vessels, and is therefore secondary to foci in the testicle. König considers that the prostate is the original seat of the disease in many cases. Those who hold the contrary theory point to the improvement in the general condition and in the urinary symptoms, and in the local condition of the prostate, which follows removal of the testicle. The sudden development of miliary tuberculosis in a patient who has tuberculosis of the testicle shows that it is capable of spreading from this source.

Experiments upon animals show that the injection of tuberculous material into the urethra is often followed by tuberculosis of the base of the bladder, or of the prostate, but never by tuberculosis of the testicle or kidney. The injection of infectious material into the testicle invariably produces tuberculosis of the corresponding seminal vesicle and prostate, even though the vas deferens be ligated. It never develops in the opposite testicle. Baumgarten, who conducted these experiments, concludes from them that infection spreads with the stream, but never against it. In the vas deferens the secretion and lymph flow in the same direction, hence prostatic infection is secondary to that of the testicle. Although the direction of the lymph-stream along the ureter is not known absolutely, it is probably downward, so that tuberculosis of the bladder may be secondary to that of the kidney, while infection probably does not spread in the reverse direction. The decision in regard to these questions has a very important bearing on the radical treatment, as will be seen below. Whatever be the source of the infection, there are other influences which help to determine the situation in which tuberculosis develops. Thus traumatism is a most important factor, as shown by clinical records and experiments upon animals. A severe contusion of a rabbit's testicle one day after the animal is injected with tubercle bacilli will set up tuberculosis in the testicle. (Simmonds.) Sometimes an acute or old gonorrhœa will seem to favor the development of tuberculosis. Some surgeons believe that a functional congestion of the organ may be a predisposing cause of tuberculosis, and that on this account the disease is most common between the twentieth and fiftieth years of life.

Diagnosis.—The involvement of the epididymis before the testis is one of the chief distinguishing marks of tuberculosis in contrast to syphilis. Tuberculosis lacks the acute exudate of acute epididymitis, and lacks, also, the intense pain, inflammatory redness and

swelling of the scrotum, and the fever, which are symptoms of that disease. The presence of nodules along the vas deferens, or fistulas or tuberculosis of other organs, especially of the prostate, seminal vesicle, or kidney, will further confirm the diagnosis.

Primary tuberculosis of the testis is not so easily diagnosticated. It must be differentiated from acute orchitis and syphilis of the testicle, and for this purpose careful history and repeated examinations of the patient may be necessary.

Prognosis.—The outcome of tuberculosis of the testicle depends not a little upon the presence or absence of the same disease elsewhere in the body. The outlook is particularly unfavorable if the case is one of a descending tuberculosis. It is better if the tuberculosis seems to be a primary affection. In all cases prognosis depends greatly upon the treatment employed.

Treatment.—There are doubtless cases in which tuberculosis of the testicle, even after the formation of fistula, has undergone calcification and cicatricial contraction, and has terminated in spontaneous cure. On this ground some surgeons recommend to patients in whom the disease is not far advanced a strengthening diet, sea-baths, etc., and such palliative operations as may be indicated. In more advanced cases all are agreed that a radical removal gives the patient the best chance of cure, although opinion differs as to the extent of such an excision. On account of the importance of the testicle, most surgeons in both France and Germany take a more conservative standpoint and castrate only in those cases in which the testis as well as the epididymis is affected. And they prefer to resect only such portions of the epididymis as are involved in the inflammation. A few surgeons split the testis in order to determine its condition, and if it is found healthy immediately suture it. Czerny and Bruns are advocates of immediate castration, and bilateral castration if necessary. They support this decision by results in a large number of cases. Bruns has records of 111 patients who were observed for periods varying from three to thirty-four years. He says that the inflammation, which in the majority of cases starts in the epididymis, soon extends to the testis, and before a great while involves the other testicle. Unilateral castration was performed in 78 cases, with complete cure in 46 per cent., and extension to the other testicle in 23 per cent. Bilateral castration was performed 33 times, with 56 per cent. of permanent cures, and in these patients the psychic disturbances so often feared after bilateral castration did not manifest themselves.

The statistics of the Berne clinic show that in 75 per cent. of cases tuberculosis of the testicle sooner or later becomes bilateral. Early castration protects the patient against this complication. However, a careful examination of the diseased testicle sometimes shows that the nodules of disease may be removed without sacrificing the organ.

Injection of iodoform emulsion is scarcely worth while. It is better to incise and curette, or burn away, the diseased tissue, and a still more rational procedure is to make a skin resection, the cut only passing through healthy tissue. In this way a part of the epididymis may be left, or, at least, the testis, if it is found that the disease has not extended so far. One can best judge of the condition of the testis after splitting it. If it is found healthy, it should be immediately sutured. Operative treatment in all cases should be followed by such measures as will strengthen the general health of the patient. Bramann obtained by partial resection cures which in several cases have lasted more than three years.

If the testis also is involved, the whole testicle and as much of the vas deferens as possible should be removed even though the seminal vesicle or prostate or bladder is already affected. Experience has shown that in some cases very ill patients are greatly improved by this operation, and the symptoms referable to the prostate and bladder may disappear entirely. If both testicles are affected, double castration should be performed if the condition of the patient is such that improvement is to be expected. It will frequently happen that even a young man is more willing to part with the diseased organ than a surgeon is to perform the operation. In such cases one may attempt improvement by curettage, injections of iodoform, and the use of the cautery; but a radical operation should not be postponed until the patient's general health suffers. Double castration under such circumstances produces no unpleasant psychic disturbances.

König has recently advocated removal of the affected seminal vesicles and prostate, but this operation is a serious one, and is not to be lightly undertaken; furthermore, as stated above, castration, together with removal of the affected spermatic cord, has given good results even when the seminal vesicles and prostate are already diseased. Bügner injects iodoform glycerin through the vas deferens before resecting the cord. Experiments upon the cadaver show that such an injection will reach the prostate and seminal vesicles.

Bügner separates the vas deferens from the cord high up, and pulls out as much as possible of its upper portion. By this means, which is called evulsion of the vas, he is often able to remove four-fifths of its length. Schede objects to this procedure on the ground that the vas is likely to rupture at some point at which there is tuberculous degeneration, so that tubercle bacilli may escape and set up infection of the peritoneum. Lauenstein experienced severe hemorrhage as a result of evulsion. The better practice, therefore, seems to be to split up the inguinal canal, resect as much as possible of the affected vas, and touch its central stump with the thermocautery. In this way one can remove the greater portion of the vas.

The technic of castration and extirpation of the seminal vesicles is given on pages 717 and 720.

SYPHILIS OF THE TESTICLE.

Unlike tuberculosis, syphilis of the testicle is usually situated in the testis. It is marked by general swelling of one or both testes without especial pain, although there may be pain due to the drag of the enlarged organ upon the spermatic cord. In some instances particular nodules may be felt.

In the beginning of the trouble the patient may be annoyed by the size of the testicle, especially if there is complicating hydrocele. At a later stage the swelling may change into fibrous contraction of the parenchyma, so that the testicle becomes hard, insensitive, and somewhat smaller than its fellow, or even very atrophic. In other cases, however, the organ increases in size until it is as large as a closed fist, or larger, and the primary infiltration of the testis

FIG. 346.

Syphilitic fungoid of the testis, as seen in sagittal section; the epididymis lies to the left; the skin of the scrotum, broken through by the fungoid growth, lies to the right. (Kocher.)

may extend through the tunica albuginea and the tunica vaginalis until it involves the skin, and finally the softened centre of the gumma breaks outward. There results an irregular-shaped ulcer, with undermined edges, which secretes very thin purulent or gangrenous fluid. Later, the ulcer may become lined with yellowish granulations which sometimes grow above the surface, giving rise to a fungus as large as an egg. Such a fungoid growth is absolutely insensitive. Its consistence varies, being harder in some spots, softer in others. The epididymis is still easily palpable through the skin of the scrotum. (Fig. 346.)

Syphilitic inflammation may extend to the epididymis, so that in advanced cases the differentiation between the testis and epididymis

is no longer possible. Primary syphilis of the epididymis is extremely rare. The vas deferens is rarely involved, although primary nodules have been observed in the vessels of the spermatic cord.

Pathological Anatomy.—Syphilis of the testicle may occur in a diffuse form or in a gummatous form. In some cases the inflammation occupies a median ground between the two. In the fibrous form of disease the connective tissue gradually compresses the parenchyma so that the seminal tubules surrounded by heavy bands of connective tissue gradually atrophy. On section the testicle is seen to be made up of firm whitish tissue. There is often an adhesive or exudative periorchitis.

Syphilitic enlargement is frequently followed by atrophy which may be general, but is more likely to occur only in spots, which will then appear drawn in like cords.

Gummatous orchitis is usually associated with the fibrous form of disease, and if so, on section there will be seen a number of irregular yellowish-white caseous nodules which rise somewhat above the cut surface. The surrounding tissue is also more or less affected and has a yellowish or reddish-gray color. If any portions of the seminal tubules still remain, they will usually be found near the posterior margin of the testis. Such gummatous nodules tend to unite, and in time the whole testicle will be destroyed. (Fig. 347.)

FIG. 347.

Syphilis of the testicle with advanced caseation. (Kocher.)

Etiology.—Syphilis of the testicle is hereditary in childhood. If acquired, it is commonest in early manhood, but may occur later. As it affects first the walls of the vessels and capillaries, it is certainly metastatic. Acquired syphilis of the testicle may show itself in connection with the secondary manifestation of the disease, but is

much more common in the tertiary period. The immediate exciting cause may be a traumatism.

Diagnosis.—Diagnosis rests particularly upon the beginning of the trouble in the testis. The testis may be as large as the fist, and while everywhere indurated enlargement and induration are more marked in those places where the disease is furthest advanced. Sometimes there will be softening in the centre of the most prominent portion, especially in the anterior portion of the testis. The condition is most characteristic when the epididymis is plainly palpable, and neither it nor the vas deferens is involved in the inflammation. If the epididymis is affected and hydrocele exists, diagnosis is not so easy. In the later stages of the disease the skin is infiltrated, reddened, and soft in spots. The gradual onset serves to distinguish syphilis from acute or chronic suppurative orchitis, but it is not so easily differentiated from tuberculosis, although the abscess formation in the latter disease leads to formation of fistulas at an earlier period. The history of the patient and the examination of other portions of his body will materially aid in diagnosis. A tumor, whether carcinoma or sarcoma, will grow more rapidly than syphilis. In doubtful cases the test of treatment with iodide of potassium will establish the diagnosis.

Prognosis.—Syphilis of the testicle does not threaten life, although rupture of and discharge from a gangrenous cavity will have some effect upon the general condition of the patient. The prognosis as to the function of the testicle is less favorable. If both testicles are affected, power of erection and secretion of semen gradually disappear unless treatment is promptly begun. Syphilis of the testicle tends to recur, so that in many cases the organ ultimately undergoes complete atrophy.

Treatment.—Iodide of potassium should be given in large doses, 4 or 5 grammes (60 to 80 grains) daily. In some cases inunctions are of benefit. Abscesses should be opened, necrotic portions of the testicle and fistulas should be curetted. If the testicle is badly diseased, it should be removed.

Leprosy and **actinomycosis** may affect the testicle. The former gives rise to nodules which may later disappear with atrophy of the organ. Actinomycosis goes on to suppuration and discharge of scanty pus containing characteristic granules. The treatment of either disease is castration.

CYSTS OF THE TESTICLE.

Many of the cysts of the testicle develop from remains of embryologic structures. Those which are worth mention are:

1. The hydatid of Morgagni is a soft long body situated at the upper pole of the testis, where it is under the head of the epididymis. It represents the remains of Müller's duct. This hydatid has no pedicle.

2. One or more pedicled hydatids may be situated at the head of the epididymis. These are due to secondary obstruction of the efferent tubules of the testis.

3. Tortuous blind passages, so-called aberrant tubules, may be found either in the head or tail of the epididymis.

4. The paradidymis, or organ of Giraldes, is composed partly of the remains of the Wolffian body and partly of seminal tubules which are cut off from the testis. It has no connection either with the testis or epididymis, and is situated under the vessels in front of the lower end of the vas deferens.

The formation of cysts of the testis and epididymis is, according to Hochenegg and Kocher, a common occurrence. Such cysts are due either to retention of lymph or they develop in effusions of blood or of semen. Cysts of the second sort are of the most importance, and have received the name of spermatoceles. They will, therefore, be considered more in detail.

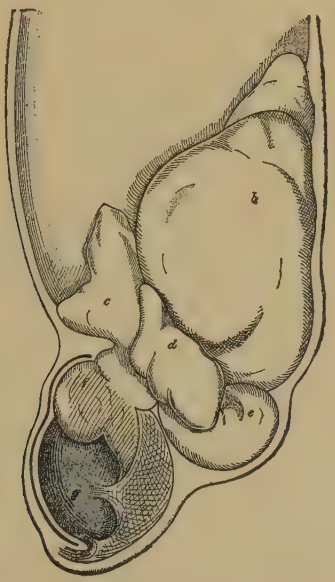
FIG. 348.

Spermatocele between the testis and epididymis, giving the testis a horizontal position. (Kocher.)

Spermatocele.—A spermatocele forms a rounded or oval tumor which is attached to the testis or epididymis at a single point. Its usual attachment to the testis is at the rete. The condition is particularly striking if it is situated between the testis and epididymis. Under such circumstances the epididymis is attached to the testis about its head and tail, while its central portion is separated from it by the cyst. (Fig. 348.) If the cyst grows upward without resistance, the testicle remains in its normal position. If the cyst grows beneath the testicle, the latter may be brought into a horizontal position.

If the spermatocele has a pedicle or grows from the tail of the epididymis, its weight may drag the epididymis downward so that the testis comes to lie above it. The spermatocele has usually a smooth surface and is easily palpable through the scrotum. Sometimes by reason of septa and constrictions it is made up of several cysts which may or may not communicate with each other. (Fig. 349.)

Fig. 349.



Multilocular spermatocele. (Kocher.)

A spermatocele has a characteristic soft and fluctuating elasticity. It is only hard when its walls are very thick. This may be the case with the so-called proliferating cystoma of the testicle, in whose walls lime salts or even bony plates are found. (Fig. 350.)

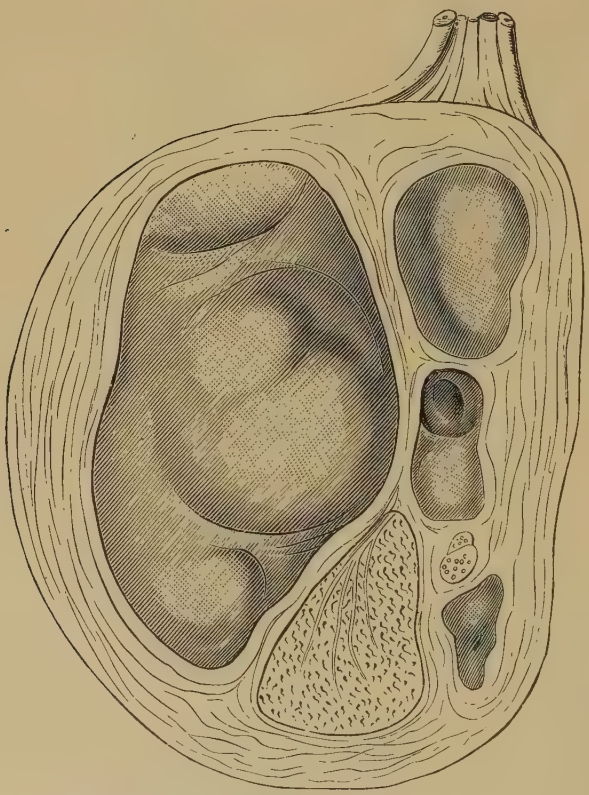
A simple spermatocele is very translucent. If its contents are mucus with flakes of fat, or if its walls are thickened, the translucency is diminished. In rare cases a spermatocele reaches the size of an apple and extends up to the external abdominal ring, or even into the inguinal canal. The usual thin-walled cyst may be ruptured by a traumatism, and if so, its contents will be scattered in the loose tissue of the spermatic cord, giving rise to a "diffuse hydrocele." Inflammation may take place within the sac, producing painful symptoms. Under ordinary circumstances the cyst is attended with no pain, or possibly with slight pain during sexual excitement.

A spermatocele is usually situated outside of the tunica vaginalis. An intravaginal cyst is usually a hydatid of Morgagni,

which may communicate with the vasa aberrantia of the testis and so contain spermatozoa. (Fig. 351.) Such an intravaginal spermatocele may rupture and discharge its contents into the tunica vaginalis, giving rise to a true hydrocele whose contents may contain spermatozoa.

Etiology.—According to investigations of Kocher and others, a spermatocele is a dilatation due to constriction by some portion of the vasa aberrantia; or to obstruction, either temporary or permanent,

FIG. 350.



Multilocular cystoma. (Kocher.)

in the lower seminal passages. Roth says that spermatocele may develop in aberrant ducts of the epididymis. Such ducts terminate blindly, or they may be connected with the hydatids of Morgagni. They are lined with ciliated epithelium, as are many spermatoceles. Others are lined with pavement epithelium. If the communication between a spermatocele and the seminal tubules is cut off, the spermatozoa in its contents will gradually disappear, although they may exist for years.

Cysts of the paradidymis contain a milky fluid, but no spermatozoa inasmuch as they have no connection with the testis or epididymis.

An attack of gonorrhœa which is recovered from may be the cause of a spermatocele since the acute gonorrhœal epididymitis may obliterate the tubules in the epididymis and so give rise to retention.

FIG. 351.

Intravaginal spermatocele.

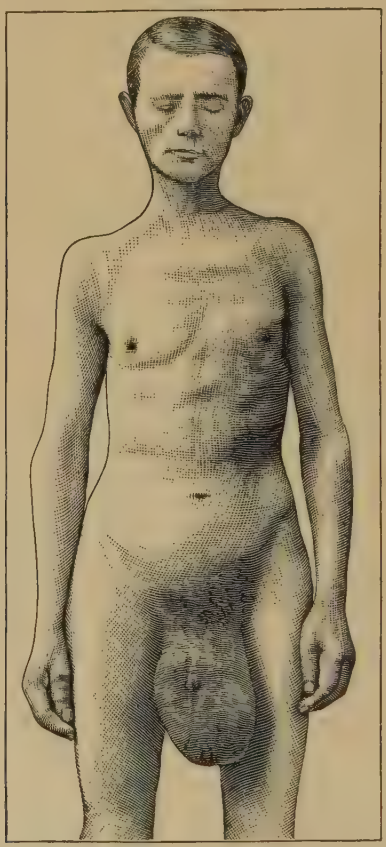
Traumatism has also been assigned as a cause. Twisting of the vas deferens has been known to produce a very large retention-cyst containing spermatic fluid. (Fig. 352.)

Diagnosis.—In most cases the cyst is easily distinguished from the testis and epididymis by palpation. This is not true of a hydrocele. A hydrocele of the spermatic cord has no connection with the testis or epididymis, while in most cases of spermatocele a slender connection, even though slight, can be made out. An intravaginal spermatocele cannot be certainly diagnosticated except by microscopical examination of its contents after aspiration. The fluid in a spermatocele may be as clear as water, or slightly milky, or soapy in appearance, while the fluid of a hydrocele is tinted yellow; the chief difference, however, is the presence of spermatozoa which in most cases are motile. Kocher gives the specific gravity of the fluid in a spermatocele as between 1.002 and 1.009; that of a hydrocele is about 1.020. The fluid has a neutral reaction, as contrasted with the alkaline reaction in a hydrocele. The milky or brownish color which the fluid in a spermatocele may have is due to a destruction of cells, the presence of drops of fat, or possibly the remains of blood-corpuscles.

Treatment.—While the prognosis of a cyst of the testicle is

thoroughly good, the best treatment for it is incision and removal of the whole sac. The overlying skin and the tunica vaginalis are divided until the wall of the cyst is reached. This is separated from the tissues of the cord and epididymis : the pedicle is found,

Fig. 352.



Spermatocele due to torsion of the vas deferens. (Sasse.)

ligated and divided, and the wound is closed. Puncture and injection of tincture of iodine, etc., are uncertain methods of treatment which are likely to be followed by recurrence.

TUMORS OF THE TESTICLE.

New growths of the testicle have great pathologic interest, since there is no organ of the body in which there are so many variations in structure as in the testicle. For the finer distinctions of testicular tumors the reader is referred to works on pathology. Only those of practical importance will be considered here.

PLATE XXIII.

FIG. 1.

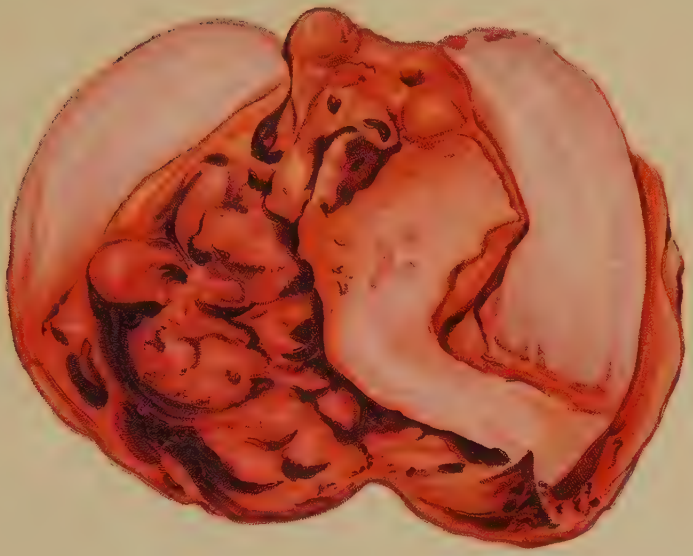
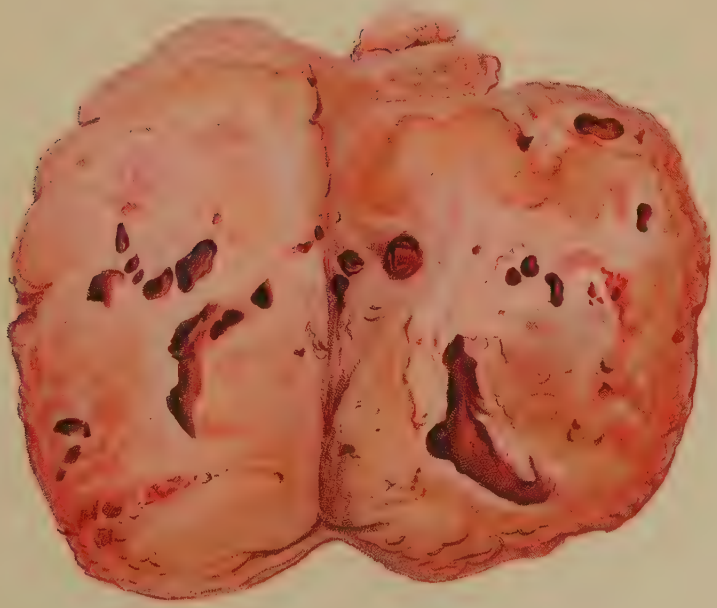


FIG. 2.



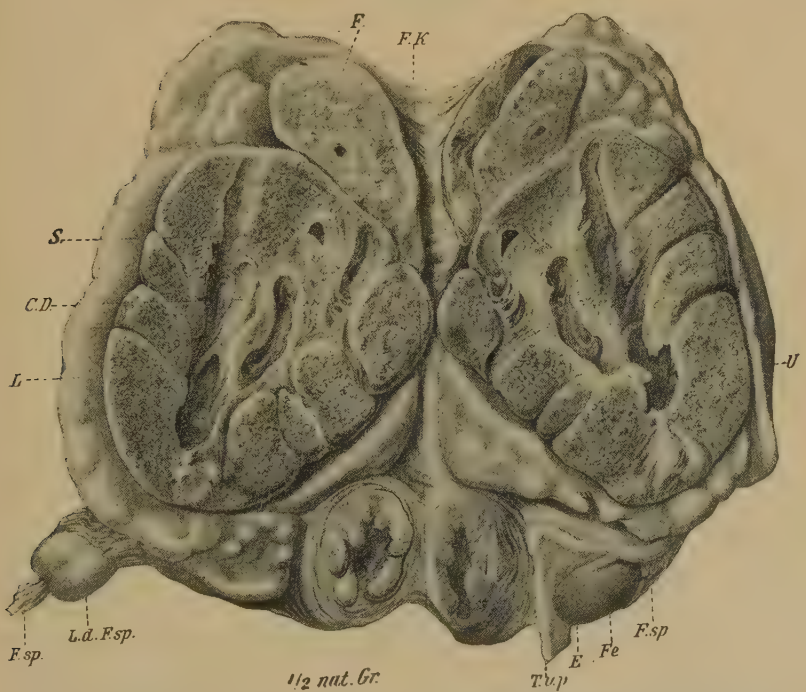
Cystic Sarcoma of Testis. (Taylor.)

In general, tumors of the testicle are rare. They may be found in childhood, especially ectopic growths. Kaufmann divides them into three classes:

1. Connective-tissue tumors; 2, epithelial tumors; 3, dermoid cysts and teratomata.

Sarcoma.—Sarcoma may affect either one or both testicles. It may be primary in the tail of the epididymis. As it grows it may so compress the normal tissue of the testicle that this appears in section as a thin layer on the surface of the tumor. (Fig. 353.) Sarcoma begins as a hard nodule and develops slowly without pain, and may

FIG. 353.



Large mixed tumor of the scrotum, mainly sarcoma, but containing in addition fibromatous elements: *E*, epididymis; *F*, fibroma; *L*, lipoma; *S*, sarcoma; *CD*, degeneration-cysts; *FK*, fibrous capsule. (Karewski.)

remain about the same size for years. At any time without obvious cause it may begin to grow, so that within a few months it reaches the size of a fist, involves the spermatic cord, breaks through the tunica albuginea, the membranes of the testicle and the skin, and forms a fungoid growth.

The more rapidly growing sarcomata are softer; those which remain quiescent are hard. The general shape of the testicle may be preserved or the tumor may produce irregularities in its outline.

Sometimes, and especially if the epididymis is involved, there is a complicating hydrocele or hæmatocele.

If the sarcoma is a round-celled one, it is likely to undergo regressive changes, such as fatty degeneration, necrosis, hemorrhages, and mucoid softening. A spindle-celled sarcoma is firmer and often contains striated muscular fibres. Other types of sarcoma are fibro-sarcoma, perivascular sarcoma in which the cells are disposed around the bloodvessels, and melanotic sarcoma. Cysts may form in the centre of the tumor by reason of mucoid softening or dilatation of the seminal tubules. Such a tumor may be spoken of as a cystosarcoma. Adenosarcoma and tumors on the border-line between sarcoma and carcinoma also occur.

Etiology.—Traumatism and imperfect descent of the testicle are said to be favoring causes of sarcoma. The tumor may also be of metastatic origin.

Diagnosis.—In an early stage the diagnosis of sarcoma of the testicle is difficult. If a hard nodule which has existed for some time begins to grow rapidly, one should think of sarcoma, especially if the patient is a child or a young adult. Carcinoma occurs in middle or advanced life and gives an irregular, rough tumor. In tuberculosis softening and formation of fistulas occur early in the history of the growth. Then, too, other organs are often affected with tuberculosis. In every case, therefore, the history should be carefully inquired into and the whole body examined. The commonest mistake in diagnosis is the confusing of syphilis with sarcoma. Kocher says that the first nodules of sarcoma appear in the posterior part of the testis and epididymis, while the reverse is true of syphilis. The use of iodide of potassium in large doses will usually clear the diagnosis. In later stages of the disease, when the spermatic cord is infiltrated and there are enlarged inguinal glands, the diagnosis is easily made. The presence of a hæmatocele in connection with a tumor should also suggest sarcoma.

The prognosis is, of course, bad. Death follows formation of metastases in the other testicle, or skin, or lungs, or brain, or bone, or retroperitoneal lymph-glands. On the other hand, an early castration and removal of any affected extratesticular tissue may bring about a permanent cure.

Benign Connective-tissue Tumors.—Fibromata are found in the tunica albuginea, the rete, testis, and inner wall of the vas deferens. Such a tumor may undergo calcification.

Lipoma of the testicle is rare. It occurs more often in connection with the spermatic cord, when it must be differentiated from hernia and hydrocele. Its dissection is usually not difficult.

A myxoma does not occur alone, but often forms a part of sarcoma, fibroma, or enchondroma.

A pure enchondroma is another rare tumor of which a few cases are on record. It is smooth, hard, and seldom exceeds a duck's egg

in size. It grows rather rapidly and may form metastases, especially in the lungs; therefore, early castration is advisable.

Osteoma of the testicle is another very rare form of tumor. Myoma is seldom found alone, but may form part of another tumor. It may be composed of either strips or smooth fibres, and may start from the cremaster or from the muscular sheath of the epididymis.

Epithelial Tumors.—The most important tumor of this group is carcinoma. It usually develops in the testis. It forms a rapidly growing tumor which may reach the size of a goose egg or even that of a child's head. In the beginning the shape of the testicle is preserved, but as soon as the tumor breaks through the tunica albuginea its shape becomes irregular and its surface presents hard nodules which are characteristic of carcinoma. In the beginning

FIG. 354.

Carcinoma of the testicle. The testis and epididymis are pressed to the right. (Kocher.)

pain may be absent. Later it is a prominent symptom, especially after metastases have formed in the inguinal and retroperitoneal glands. The patient then complains of tension in the epididymis, of disturbed digestion and defecation, œdema of the legs from pressure upon the vena cava, anæmia from metastases in the liver, lungs, etc.

The tumor is usually of a medullary type and is grayish-red on section before fatty degeneration and caseation take place in spots. Carcinoma is supposed to develop from the epithelium of the convoluted tubules, especially in the peripheral portion of the testis. As it grows it presses the normal structures of the testis before it. The epididymis is involved either not at all or at a late period. (Fig. 354.)

The diagnosis of carcinoma of the testicle is a difficult one to make in the early stage of the disease. A hard nodule appears in the testis, grows rapidly, and does not involve the epididymis. Particular attention should be given to the dilatation of the vessels of the spermatic cord. The diagnosis is more difficult if the tumor is complicated with hydrocele. The age of the patient may suffice to exclude tuberculosis and syphilis. Later, when the tumor becomes uneven or involves the inguinal glands diagnosis is clear.

Traumatism, gonorrhœa, and syphilis have been mentioned as predisposing causes of carcinoma.

Prognosis is very unfavorable, and castration should be performed as soon as the diagnosis is made. Any affected lymph-glands should naturally be excised. Several surgeons have reported freedom from recurrence lasting several years after radical operation.

Adenoma.—Adenoma of the testicle occurs in both children and adults. It develops from the seminal tubules and forms a tumor which often contains cysts filled with mucus in which there are no spermatozoa, or with yellowish atheromatous material. Many of these tumors merit the name "cystadenoma." Such tumors have been variously ascribed to traumatism and to errors of development. An adenoma grows rapidly, without pain, and may reach the size of a child's head. Its shape is a flat oval. It has a smooth surface, and firm, elastic consistence. If large cysts are present, they will fluctuate, and if the skin over them is thin a bluish color may be noticeable. In an early stage the diagnosis is difficult, and a rapid growth of the tumor suggests malignancy. Aspiration of a mucoid, cloudy fluid will serve to differentiate the growth from hydrocele. Prognosis is favorable in pure adenoma, but as an adenoma also occurs in connection with carcinoma, sarcoma, enchondroma, and myoma, one ought always to treat it by castration.

Dermoid Cysts and Teratomata.—These unusual forms of tumors are seen for the most part in the first year of life. They increase in size as the body grows, without causing pain. At puberty they may take on a more rapid growth so as to become as large as a child's head. Their consistence is firm, tense, and sometimes indistinctly fluctuating. They are not tender on pressure unless they become inflamed. They contain atheromatous fluid in which may be found hair, teeth, and rudiments of bone. The diagnosis rests chiefly upon the history of a tumor at birth which has grown slowly without pain. This is confirmed by aspiration. If hairs are found in the aspirated fluid, the diagnosis is absolutely certain. These tumors, according to Wilms, are not simple inclusion-cysts of the skin, but are true teratomata formed of all three embryonic layers exactly as the dermoid cysts of the ovaries.

Although these teratomata are benign tumors, they are liable to suppuration, or to sarcomatous or carcinomatous degeneration ; therefore they should be removed. The testicle is always flattened against

the posterior side of the tumor, but can be definitely palpated. In some cases it is possible to pull the cyst-wall away from the testicle so that the organ may be preserved. In other cases castration is necessary.

Wilms also describes a number of solid tumors of the testicle: cystosarcoma, cystocarcinoma, cystadenoma, rhabdomyoma, etc., which are embryonic tumors made up of three layers. In such tumors one may find glands, cartilage, and muscle.

CASTRATION.

The indications for removal of a testicle are severe injury, threatening gangrene, septic processes, the existence of gangrene, tuberculosis, many forms of syphilis, malignant tumors, and such benign tumors as inconvenience the patient and cannot be removed with preservation of the testicle.

The best incision for castration is a longitudinal one extending from the external abdominal ring to the raphe of the scrotum. The skin, tunica dartos, and remaining layers of the testicle are divided until the organ itself is exposed. If it is attached to the skin by reason of new growth, or inflammation, or a fistula, an oval portion of the scrotum should be removed with the testicle.

In many cases one prefers to make a short incision into the testicle in order to confirm the diagnosis, and if castration is then indicated, to close the wound in the testicle with gauze and suture, in order not to infect the superficial wound. As the testicle lies loosely in the subcutaneous tissue of the scrotum, it can be shelled out without difficulty. The spermatic cord is freed from surrounding tissues as far as the external abdominal ring. The vas deferens is next found and separated from the vessels of the cord, and in some cases—for example, in tuberculosis, the inguinal canal is split up so that as much as possible of the vas may be removed. Light traction is made upon the vas, and it is divided with a Paquelin cautery, so that the central stump of it may not infect the tissues. The vessels of the cord are then ligated in two portions and divided. Any hemorrhage is checked, and in aseptic cases the wound is completely closed by suture. If there is a chronic suppuration—for example, in tuberculosis—a drain should be placed in the lower angle of the wound. If castration is performed on account of acute suppuration or gangrene, the wound should be left open and tamponed. When performing this operation the surgeon should look out for existing hernia or bilocular hydrocele, and in case the peritoneal cavity is opened, the wound in the peritoneum should be closed by suture. If a hernia is present, the pillars of the abdominal ring should be sutured in order to cure the hernia.

CHAPTER XXXVII.

DISEASES OF THE SEMINAL VESICLES.

The seminal vesicles can be felt by palpation within the rectum. They lie above and behind the prostate, with their anterior surfaces against the neck and fundus of the bladder, and their posterior surfaces directed toward the rectum. They are separated from its muscles by only a thin layer of connective tissue. To the examining finger in the rectum they feel as flattened cylindrical bodies, beginning at the upper margin of the prostate and extending so high up that their upper ends cannot usually be reached. For a distance of about 2 cm. (0.8 inch) they lie close together; higher up they are farther apart.

The seminal vesicles secrete a yellowish fluid which is mixed with the semen which enters them through the vasa deferentia. If one presses the seminal vesicle with the finger from above downward, its contents can be expressed into the urethra, appearing at the meatus, or into the bladder, whence it may be obtained by irrigation or urination. Before obtaining this fluid for examination it is well to express the secretion of the prostate, and to wash it out of the bladder by irrigation.

The seminal vesicles may be wanting. This anomaly is usually seen in connection with failure of the other generative organs, defect of the prostate, malformation of the bladder, rectum, or penis. They may atrophy as a result of early castration, or of inflammation, or of old age.

The seminal vesicles may be injured in fracture of the ischium, and they have frequently been injured in perineal lithotomy, less often in resection of the rectum. The result is cicatricial contraction and obstruction of the ejaculatory ducts, although sometimes a seminal fistula persists.

The seminal vesicles may be inflamed as the result of traumatism, or acute, or, more often, chronic gonorrhœa. The symptoms are not very characteristic because inflammation of the urethra, prostate, bladder, and testicle usually coexists. The patients complain of continuous dragging pain in the sacral region, or pain in the rectum, or painful micturition. Upon rectal examination the seminal vesicles will be found to be enlarged and very tender, while the prostate is of normal size. Blood and pus may come from the urethra during defecation or urination. A characteristic symptom is the so-called hæmaspermia, or the discharge during coitus, or involuntarily, of

semen stained a chocolate-brown from admixture of blood. Pyospermia has also been observed. Kocher mentions the occurrence of œdema and redness of the skin in the region of the posterior inferior spine of the ilium in a case of suppuration of the seminal vesicles.

Inflammation of the seminal vesicle, or spermatocystitis, is usually a chronic trouble which gradually destroys the mucous membrane and often produces complete atrophy of the organ. In acute suppuration the infection may spread to the peritoneum.

Prognosis is unfavorable as far as function of the organ is concerned, but there is no risk to life except in the acute cases. At such times treatment should be prompt. Formerly it was customary to puncture the seminal vesicle through the rectum or through the perineum, but the modern treatment is to evacuate it by incision in one of these situations. In chronic spermatocystitis Jadassohn, Swinburne, Fuller, and others recommend massage, extraction of the contents of the diseased vesicle either with the finger or with an instrument devised by Feleki—a metal ball on a long handle. The manipulation is repeated every two to four days in order to keep the affected vesicle from distention.

Long-continued inflammation of the seminal vesicle may lead to dilatation and the formation of a cyst even though the ejaculatory duct is not obliterated. Such a cyst may contain a brownish mucous fluid.

Stagnation of the secretion may lead to the formation of calculi of calcium carbonate or phosphate. Epithelial cells and spermatozoa may block the ejaculatory duct and give rise to colic and aspermia. This condition is usually found in old people. It may produce, in addition to colic, pain on urination, vesical tenesmus, and increased sexual irritability. On palpation, the distention of the seminal vesicle will be recognized. The ejaculation will fail during coitus.

If a sound is passed into the urethra, a calculus can be pressed by it against the examining finger in the rectum.

Tuberculosis of the seminal vesicle is a frequent complication of tuberculosis of the epididymis, but it rarely occurs primarily. The diseased vesicle may be as large as a walnut and contain hard nodules. On cross-section its wall will be seen to be thickened, and in places caseated. Its inner surface will be irregular, its lumen contracted in places, and in other places dilated on account of ulceration. The whole mucous lining may be destroyed, the cavity in such cases being filled with cheesy pus.

The diagnosis of tuberculosis will rest upon the presence of this disease in other organs and upon the rectal examination. In the early stages the seminal vesicle is hard and nodular, while in the later stages it will be soft in spots, and there may be fistulas leading to the bladder, rectum, or perineum.

Bruns and others have noticed that tuberculosis of the sem-

inal vesicle is checked in its progress by removal of the affected testicle. Indeed, the seminal vesicle may undergo cicatricial contraction. Therefore, a tuberculous seminal vesicle should only be removed in case the inflammation is rapidly extending in an otherwise healthy patient, or in case the testicle is not affected, and the disease in a seminal vesicle appears primary.

The seminal vesicle is best removed by the perineal method of Zuckerkandl. The intestine is thoroughly emptied and irrigated, and the patient is put in the lithotomy position. The left forefinger is inserted into the rectum as a guide, and a transverse incision, curving somewhat around the anus, is made in the perineum. This should be 6 to 8 cm. (2.4 to 3.2 inches) in length and divide the skin and subcutaneous tissue. Next, the union of the sphincter ani and bulbocavernosus muscles is cut through and the rectum and urethra separated by blunt dissection. This dissection is continued until the prostate is exposed and separated from the rectum. The base of the seminal vesicles will then be reached. The affected organ is carefully freed from the bladder and rectum by further blunt dissection, care being taken not to open the peritoneum in Douglas's fossa. When the seminal vesicle is completely isolated, it is removed, and any existing tuberculous foci in the prostate are curetted away. Other surgeons prefer to expose the seminal vesicle and prostate by temporary resection of the coccyx and lower portion of the sacrum according to Kraske. The rectum is then pushed to one side and an excellent view is obtained of the prostate, seminal vesicle, and vas deferens. This operation is more serious than the perineal one.

Primary tumors of the seminal vesicles are very rare. Tumors of these organs are usually metastatic growths from the prostate, bladder, testicle, or spermatic cord. The radical removal of a tumor had best be carried out through a sacral incision.

INDEX.

ABDOMINAL resection of rectum, 166
Abnormal urethral openings, 225
diagnosis of, 227
treatment of, 228
Abnormalities, congenital, of bladder, 428
of kidney, 218
changes in form, 218
in number, 218
of ureter, 221
Abscess about anus, 108
ischiorectal, 107
of kidney, 285
pelvirectal, 110
perinephritic, 336
tubercular, 320
Absence of urethra, 570
Acetabulum, fracture of, 26
Actinomycosis of kidney, 348
of testicle, 707
Addison's disease, 416
Adenocystoma of kidney, 368
diagnosis of, 370
treatment of, 370
Adenoids of rectum, 146
diagnosis of, 147
symptoms of, 146
treatment of, 147
Adenoma of bladder, 523
of kidney, 353
of testicle, 716
Adenosarcoma, embryonic, of kidney, 360
Adhesive periorchitis, 684
Albarran's ureter cystoscope, 201
Allingham's ligature-carrier, 135
Amputation of penis, 651
Aneurisms, gluteal, 61
diagnosis of, 62
treatment of, 62
inguinal, 59
treatment of, 60
of pelvic arteries, 59
of renal arteries, 373
treatment of, 374
Angioma of penis, 645
Angioneurotic hemorrhage, 342
Angiosarcoma of kidney, 358
Anomalies, congenital, of penis, 625
of scrotum, 653
Anuria, due to calculi of kidney, 302
after renal injury, 236
Anus, abscess about, 108
congenital malformations of, 83
diseases of, 97
fissure of, 104
Anus, fissure of, diagnosis of, 105
examination of, 105
prognosis of, 105
symptoms of, 105
treatment of, 106
furunculosis of, 98
treatment of, 98
imperforate, 83
prolapse of, 136
causes of, 137
etiology of, 137
pathological anatomy of, 136
symptoms of, 138
treatment of, 139
stricture of, 117
etiology of, 117
treatment of, 118
syphilitic affections of, 101
prognosis of, 103
symptoms of, 102
treatment of, 103
tuberculosis of, 103
treatment of, 104
tumors of, 144
benign, 144
treatment of, 144
malignant, 144
prognosis of, 145
symptoms of, 145
treatment of, 145
Appendicitis and movable kidney, 250
Arteries, 75
gluteal, inferior, ligation of, 75
stab-wounds of, 39
superior, ligation of, 75
iliac, common, ligation of, 75
external, ligation of, 75
internal, ligation of, 75
pelvic, aneurisms of, 59
pudic, internal, ligation of, 75
renal, aneurisms of, 373
treatment of, 374
Aseptic catheter, 485
Atresia ani, 83
et recti, 83
recti, 84

BALANOPOSTHITIS, 637
symptoms of, 638
Bardenheuer's incision in lumbar nephrectomy, 398
transverse incision for suprapubic section, 532

Bean's incision in lumbar nephrectomy, 396
Bergmann's incision in lumbar nephrectomy, 397
Bilocular hydrocele, 676
Bladder, adenoma of, 523
appearance of, in cystitis, 474
calculi of, 499
analysis of, 501
cystitis due to, 498
examination for, 507
by cystoscope, 508
tenesmus due to, 506
treatment of, 510
and urethra, 505
urine in, 506
carcinoma of, 524
cystophotographs of, 528
catarrh of, 470
from tumor, 526
cleft of, 429
congenital abnormalities of, 428
cystitis due to, 498
cysts of, 524
diseases of, 464
double, 446
drainage of, in cystitis, 489
ectopia of, complete, 428
incomplete, 428
eversion of, 428
etiology of, 429
treatment of, 432
examination of, by cystoscope, 424
digital, 195, 426
by instruments, 421
physical, 419
fistulas of, traumatic, 456
forceps with electric lamp, 534
foreign bodies in, 459
diagnosis of, 461
symptoms of, 461
treatment of, 462
hemorrhage of, from tumor, 525
hernia of, 464
operation for, 468
hypertrophy of, result of cystitis, 476, 482
inflammation of, 470
treatment of, 485
injuries of, 447
associated with external injuries, 454
diagnosis of, 455
treatment of, 455
urinary fistula following, 456
treatment of, 457
irrigation of, technic of, 493
myoma of, 524
myxoma of, 524
papilloma of, benign, cystophotographs of, 528
multiple villous, 523
solitary, 523
prolapse of, 464
rectum used as, 442
Bladder, rupture of, 447
diagnosis of, 450
intraperitoneal, 451
operation for, 453
symptoms of, 449
through external wound, 454
treatment of, 452
sarcoma of, 524
syringe, 488
tuberculosis of kidney from, 322
tumors of, 521
cystitis due to, 499
diagnosis of, 527
etiology of, 525
involving ureter, 535
pathological anatomy of, 521
removed through cystoscope, 530
resection for, 534
symptoms of, 525
treatment of, 529
wounds of, perforating, 455
Blood-clots in ureters, 193
Bodenhammer's rectocolonic speculum, 79
Bones of pelvis, tuberculosis of, 50
diagnosis of, 52
treatment of, 52
Bottini's prostatic incisor, 557
Bougies à boule, 602
dilating, for rectum, 122
Brodie's catheter for hypertrophy of prostate, 551
Brown's ureter cystoscope, 202

CALCIUM oxalate, vesical calculi composed of, 503
Calculi, prostatic, 561
of seminal vesicles, 719
in urethra, 619
diagnosis of, 620
prognosis of, 620
symptoms of, 619
treatment of, 620
of ureter, impacted, 387
vesical, 499
composed of calcium oxalate, 503
of cystin, 503
of phosphates, 502
of urates, 502
of uric acid, 502
cystophotographs of, 510
diagnosis of, 507
facetted, 505
and phosphatic crusts with chronic cystitis, 504
prognosis of, 509
symptoms of, 505
treatment of, 510
lateral perineal lithotomy in, 511
lithotomy in women in, 514
lithotrity in, 514
suprapubic cystotomy in, 511
Calculus of bladder, 499

Calculus of bladder, analysis of, 501
cystitis due to, 498
examination for, 507
by cystoscope, 508
tenesmus due to, 506
treatment of, 510
and urethra, 505
urine in, 506
of kidney, 293
analysis of, 298
anuria due to, 302
causes of, 294
chemical composition of, 295
demonstrated by *x*-ray, 306
diagnosis of, 303
effect of, 298
form of, 295
hemorrhage from, 301
method of origin of, 295
number of, 298
pain in, 300
pathological anatomy of, 298
symptoms of, 300
treatment of, 307
method of operation, 313
urine in, 299
vesical irritation due to, 303
Carcinoma of bladder, 524
cystophotographs of, 528
of Cowper's glands, 623
of kidney, 355
of penis, 646
diagnosis of, 650
etiology of, 647
prognosis of, 650
treatment of, 651
ulcer due to, 650
of prostate gland, 563
of rectum, 148
after-treatment of, 168
diagnosis of, 153
etiology of, 152
pathological anatomy of, 148
prognosis of, 168
symptoms of, 152
treatment of, 154
choice of operation, 169
functional results of, 170
inoperable, 173
methods of operation, 156
abdominal, 166
circular incision, 156
dorsal, 159
partial excision, 156
perineal, 157
vaginal, 166
preparation of patient, 155
radical operations, indications for, 154
late results of, 172
of scrotum, 666
of testicle, 715
of urethra, 622
Carcinoma of urethra, treatment of, 623
Caspar's ureter cystoscope, 201
Castration, 717
for hypertrophy of prostate, 559
Catarrh of bladder, 470
from tumor, 526
Cathelin's urine segregator, 209
Catheter, aseptic, 485
cystoscopic evacuation, 519
retention, 595
Catheterization, urethral, 195
Kelly's, 196
Pawlik's, 196
Simon's, 196
Catheters for hypertrophy of prostate, 551
Caudal growths in man, 19
Cavernitis, 641
Cellulitis of penis, 640
Chancroid of rectum, 101
Circumcision, 630
Clamp, varicocele, 690
Cleft of bladder, 429
division of sacro-iliac synchondrosis for, 437
extirpation for, 439
operation for, 432
Coccygodynia, 43
treatment of, 44
Coccyx, tumors of, 20
dorsum of, 20
Colic, renal, 346
due to nephritis, 346
Colon, relation of, to kidney, 180
Colopexy, 142
Compressor, orchitis, 699
varicocele, 690
Congenital abnormalities of bladder, 428
of kidneys, 218
changes in form, 218
in number, 218
of ureter, 221
anomalies of penis, 625
of scrotum, 653
fistula of rectum, 86
hydrocele, 676
malformations of anus, 83
of pelvis, 17
of rectum, 83
of urethra, 569
phimosis, 626
symptoms of, 627
treatment of, 628
strictures of urethra, 571
tumors of sacrum, 17
causes of, 18
diagnosis of, 20
treatment of, 21
Constrictions of penis, 632
of urethra, 570
Contusions of epididymis, 693
diagnosis of, 693
symptoms of, 693
treatment of, 693
of testicle, 693
diagnosis of, 693

Contusions of testicle, symptoms of, 693
treatment of, 693
Cord, spermatic, diseases of, 668
fibroma of, 687
hæmatocele of, chronic, 665
prognosis of, 686
treatment of, 686
complications of, 686
hæmatoma of, 668
hydrocele of, acute, 672
symptoms of, 672
bilocular, 676
chronic, 673
diagnosis of, 676
pathological anatomy of, 673
prognosis of, 679
symptoms of, 675, 685
treatment of, 679, 685
complications of, 686
congenital, 676
diffuse, 686
multilocular, 686
treatment of, 686
lipoma of, 687
membranes of, acute inflammations of, 670
chronic inflammation of, 673
injuries of, 668
tumors of, 687
sarcoma of, 687
Corpora cavernosa, laceration of, 632
Cortex of kidney, tumors of, 364
Cowper's glands, carcinoma of, 623
diseases of, 624
diagnosis of, 624
treatment of, 624
fistula of, 624
inflammation of, 624
suppuration of, 624
Credé's rectal bougie, 121
Crushes of pelvis, 38
treatment of, 39
Cryoscopy, 213
Cystic dilatation of ureters, 227
teratoma of kidney, 372
tumors of kidney, 366
Cystin, vesical calculi composed of, 503
Cystitis, 470
appearance of bladder in, 474
chronic, treatment of, 492
diagnosis of, 478
diphtheritic, 476
drainage of bladder in, 489
due to calculus of bladder, 498
to hypertrophy of prostate, 497
to stricture, 497
to tumors of bladder, 499
etiology of, 470
following gonorrhœa, 495
symptoms of, 496
pericystitis, 483
hypertrophy of bladder result of, 476, 482
Cystitis, instillations for, 489
interstitial, 482
irrigations for, 493
membranous, 476
pathological anatomy of, 474
suppurative, 481
symptoms of, 477
traumatic, 471
treatment of, medical, 487
operative, 489
prophylactic, 485
tuberculous, 495
urinary sediment in, 480
urine in, 477
three-glass test for, 478
Cystocele, vaginal, 469
diagnosis of, 470
etiology of, 469
pathological anatomy of, 469
prognosis of, 470
symptoms of, 470
Cystoma, multilocular, 710
Cystophotographs of benign papilloma of bladder, 528
of carcinoma of bladder, 528
of vesical calculi, 510
Cystoscope, Albarran's, 201
Brown's, 202
Caspar's, 201
in examination of bladder, 424
for calculi of bladder, 508
of suppurative nephritis, 289
of tuberculosis of kidney, 326
Nitze's operating, 531
tumor of bladder, removed through, 530
ureter, 203
Cystoscopic evacuation catheter, 519
Cystotomy, suprapubic, in treatment of hypertrophy of prostate, 555
Cysts of bladder, 524
of hydatid of Morgagni, 707
of kidney, echinococcus, 366
paranephritic, 372
simple, 367
solitary, 371
treatment of, 372
of penis, 643
of prostate, 564
of scrotum, 666
dermoid, 666
sebaceous, 666
of testicle, 707
dermoid, 716
of ureter, 391

D'ANTONA'S incision in lumbar nephrectomy, 397
Degeneration, polycystic, of kidney, 367
Dermoid cysts of scrotum, 666
of testicle, 716
Diffuse hydrocele of spermatic cord, 686
Dilatation of urethra, 570
Dilatations, suppurative, of kidney, 283
diagnosis of, 288

Dilatations, suppurative, of kidney, pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
Dilating bougies for rectum, 122
Dilator, prepuce, 629
and urethrometer, 604
Diphtheritic cystitis, 476
Dislocation of pelvis, 38
one-half of, 38
prognosis of, 38
of penis, 634
of sacrum, with involvement of both sacro-iliac joints, 38
of testicle, 693
Double bladder, 446
ureter, 225
Dumb-bell-pessary, 131
Duplay's operation for epispadias, 577

ECHINOCOCCUS cysts of kidney, 366
of pelvis, 71
prognosis of, 72
symptoms of, 72
treatment of, 72
Ectopia of bladder, complete, 428
incomplete, 428
Electrolysis for stricture of urethra, 610
Elephantiasis of penis, 642
of scrotum, 663
Embryonic adenosarcoma of kidney, 360
Enchondroma of testicle, 714
Endoscope, urethral, 565
Endoscopic tube, 200
Endothelioma of kidney, 358
Epicystotomy, 228
Epididymis, contusions of, 693
diagnosis of, 693
symptoms of, 693
treatment of, 693
diseases of, 693
inflammation of, acute, 694
injuries of, 693
tuberculosis of, 699
etiology of, 701
pathological anatomy of, 700
prognosis of, 703
treatment of, 703
Epididymitis, acute, 694
diagnosis of, 695
prognosis of, 696
symptoms of, 694
treatment of, 696
chronic, 696
Epispadias, 574
diagnosis of, 576
etiology of, 574
pathogenesis of, 574
prognosis of, 576
symptoms of, 576
treatment of, 576
operation of Duplay, 577
Epispadias, treatment of, operation of Rosenberg, 581
of Thiersch, 578
Erysipelas of penis, 641
of scrotum, 662
Evacuation catheter, cystoscopic, 519
pump for use in lithotrity, 518
Eversion of bladder, etiology of, 429
treatment of, 432
Excentric hypertrophy of prostate, 548
Excision of seminal vesicles, 720

FACETTED vesical calculi, 505
Fessenden-Otis urethrotome, 611
Fever, urethral, 568
Fibroma of kidney, 353
of prostate gland, 562
of spermatic cord, 687
of testicle, 687
of tunica vaginalis, 687
Fissura vesicæ, inferior, 428
superior, 428
umbilicalis, 428
Fissure of anus, 104
diagnosis of, 105
examination of, 105
prognosis of, 105
symptoms of, 105
treatment of, 106
Fistula in ano, 111
diagnosis of, 114
etiology of, 111
internal orifice of, 112
pathological anatomy of, 111
prognosis of, 114
symptoms of, 114
treatment of, 114
tuberculous, 116
of bladder, traumatic, 456
complete occlusion of rectum without, 87
congenital, of rectum, 86
of Cowper's glands, 624
of kidney, to obtain urine, 211
occlusion of rectum combined with, 90
urachal, 428
of ureter, 378
operation for, 379
protection during, 380
of urethra, 614
diagnosis of, 615
prognosis of, 615
treatment of, 615
urinary, following injuries of bladder, 456
treatment of, 457
Forceps, bladder, with electric lamp, 534
for removing vesical growths, 533
Foreign bodies in bladder, 459
diagnosis of, 461
symptoms of, 461
treatment of, 462
in rectum, 94
diagnosis of, 95

Foreign bodies in rectum, symptoms of, 94
treatment of, 95
in urethra, 616
diagnosis of, 617
prognosis of, 618
symptoms of, 617
treatment of, 618
Fracture of acetabulum, 26
of ilium, 28
of penis, 631
of sacrum, 27
Freudenberg's prostatic incisor, 557
Furunculosis of anus, 98
treatment of, 98

GANGRENE of scrotum, 662
Gland, prostate, anatomy of, 539
anomalies of, 541
calculi of, 561
carcinoma of, 563
cysts of, 564
diseases of, 539
examination of, 540
fibroma of, 562
function of, 541
hypertrophy of, 545
catheters for, 551
cystitis due to, 497
diagnosis of, 550
etiology of, 549
excentric, 548
false passage in, 553
removal of vas deferens for, 560
stages of, 549
symptoms of, 549
treatment of, 550
castration in, 559
prostatectomy in, 566
prostatotomy in, 456
sexual operation for, 559
suprapubic cystotomy in, 555
urine in, 555
inflammation of, 542
prognosis of, 543
symptoms of, 543
treatment of, 544
injuries of, 542
sarcoma of, 562
stricture of, cystitis due to, 497
syphilis of, 545
tuberculosis of, 545
tumors of, 562
Glands, Cowper's, carcinoma of, 623
diseases of, 624
diagnosis of, 624
treatment of, 624
fistula of, 624
inflammation of, 624
suppuration of, 624
suprarenal, functions of, 416
tuberculosis of, 417
tumors of, 417
Glandular hypospadias, 582
Glans penis, imperforate, 570
Gluteal aneurism, 61
diagnosis of, 62
treatment of, 62
artery, inferior, ligation of, 75
stab-wounds of, 39
superior, ligation of, 75
Gonorrhœa, cystitis following, 495
symptoms of, 496
Gonorrhœal inflammations of rectum, 99
etiology of, 99
prognosis of, 100
symptoms of, 99
treatment of, 100
ulcers of rectum, 99
etiology of. 99
prognosis of, 101
symptoms of, 99
treatment of, 101
Guthrie's catheter for prostatic hypertrophy, 551
Guyon's bladder syringe, 488
incision in lumbar nephrectomy, 395
stone-searcher, 422

HÆMATOCELE of spermatic cord, acute, 682
treatment of, 684
chronic, 685
prognosis of, 686
treatment of, 686
complications of, 686
Hæmatoma of spermatic cord, 668
of testicle, 668
Hæmaturia, significance of 235
Hæmophilia, renal, 342
Hemorrhage, angioneurotic, 342
of bladder, from tumor, 310
after examination of urethra, 567
of kidney due to tumors, 351
from movable kidney, 341
in pregnancy, 341
from rectum, 92
renal, 329
essential, 340
diagnosis of, 343
treatment of, 343
from traumatism, 342
into tunica vaginalis, 669
in uronephrosis, 341
Hemorrhagic periorchitis, 682
treatment of, 684
perispermatitis, 685
prognosis of, 686
treatment of, 686
Hemorrhoids, 124
catarrh from, 129
examination of, 130
external, 125
internal, 125
prolapse of, 128
pathological anatomy of, 126
prognosis of, 130
prolapsed, 129

Hemorrhoids, supporters for, 131
symptoms of, 127
treatment of, 130
operative, 132
Hernia of bladder, 464
operation for, 468
vesical, 464
Hey's catheter for prostatic hypertrophy, 552
Hydatid of Morgagni, cysts of, 707
Hydrocele of spermatic cord, acute, 672
symptoms for, 672
bilocular, 676
chronic, 673
diagnosis of, 676
pathological anatomy of, 673
prognosis of, 679
symptoms of, 675, 685
treatment of, 679, 685
complications of, 686
congenital, 676
diffuse, 686
multilocular, 686
treatment of, 686
Hydronephrosis, 261
Hypernephroma of kidney, 361
Hypertrophy of bladder, result of cystitis, 476, 482
of prostate, 545
catheters for, 551
cystitis due to, 497
diagnosis of, 550
etiology of 549
excentric, 548
false passages in, 553
removal of vas deferens for, 560
stages of, 549
symptoms of, 549
treatment of, 550
castration in, 559
prostatectomy in, 556
prostatotomy in, 556
sexual operation for, 559
suprapubic cystotomy in, 555
urine in, 555
Hypospadias, 581
glandular, 582
penile, 583
scrotal, 584
diagnosis of, 584
etiology of, 584
pathogenesis of, 584
prognosis of, 585
symptoms of, 584
treatment of, 585

ILIAC artery, common, ligation of, 75
external, ligation of, 75
internal, ligation of, 75
Ilium, fracture of, 28
Imperforate anus, 83
glans penis, 570
Inflammations of bladder, 470
Inflammations of bladder, treatment of, 485
of Cowper's glands, 624
of epididymis, acute, 694
of kidneys, chronic, 316
suppurative, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
of membranes of spermatic cord, chronic, 673
of penis, 637
in periproctal connective tissue, 106
etiology of, 106
pathological anatomy of, 107
treatment of, 110
of prostate, 542
prognosis of, 543
symptoms of, 543
treatment of, 544
of rectum, 97, 98
gonorrhœal, 99
etiology of, 99
prognosis of, 100
symptoms of, 99
treatment of, 101
and its neighborhood, 97
of scrotum, 661
of seminal vesicles, 719
of testis, acute, 694
of tunica vaginalis, 670
of ureters, 389
Inflammatory infections of pelvis, 45
strictures of urethra, 599
Inguinal aneurism, 59
treatment of, 60
Intermittent uronephrosis, 276
Interstitial cystitis, 482
Intertrigo, 97
symptoms of, 97
treatment of, 97
Intravaginal spermatocele, 711
Ischiorectal abscess, 107

JOINTS of pelvis, tuberculosis of, 50
diagnosis of, 52
treatment of, 52

KELLY'S proctoscope, 80
ureteral catheterization, 196
Kelsey's pile-clamp, 133
Kidneys, abscess of, 285
absence of one, 218
actinomycosis of, 348
adenocystoma of, 368
diagnosis of, 370
treatment of, 370
adenoma of, 353
anatomical characteristics of, 175
angiosarcoma of, 358

Kidneys, arterial supply of, 182
calculus of, 293
analysis of, 298
anuria due to, 302
causes of, 294
chemical composition of, 295
demonstration of, by x-ray, 306
diagnosis of, 303
effects of, 298
forms of, 295
hemorrhage from, 301
method of origin of, 295
number of, 298
pain in, 300
pathological anatomy of, 298
symptoms of, 300
treatment of, 307
method of operation, 313
urine in, 299
vesical irritation due to, 303
carcinoma of, 355
congenital abnormalities of, 218
changes in form, 218
in number, 218
cortex of, tumors of, 364
cystic teratoma of, 372
cysts of, echinococcus, 366
paranephritic, 372
simple, 367
solitary, 371
treatment of, 372
diseases of, 245
changes in urine in, 193
embryonic adenosarcoma of, 360
endothelioma of, 358
epithelioma of, 358
examination of, 186
aspiration in, 193
palpation in, 186
percussion in, 192
through median or lumbar incision, 212
x-ray, 193
extirpation of, clinical results of, 406
fibroma of, 353
fistula of, to obtain urine, 211
functional activity of, shown by Beckmann's apparatus, 216
by phloridzin test, 216
hypernephroma of, 361
infection of, 283
suppuration in, pathology of, 285
symptoms of, 284
inflammations of, chronic, 316
suppurative, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
Kidneys, injuries of, 229
death from, 236
open wounds, 240
peritonitis after, 237
without open wounds, 229
diagnosis of, 237
prognosis of, 238
suppuration after, 247
symptoms of, 232
treatment of, 238
lipoma of, 353
morcellement of, 401
movable, 245
and appendicitis, 250
cause of, 245
decortication of, 253
diagnosis of, 249
etiology of, 245
fixation of, 252
hemorrhage from, 341
nerves of, 185
suture of, results of, 207
treatment of, 251
uronephrosis in 264
neuralgia of, 344
normal supports of, 176
operations on, 393
pelvis of, incision into, 185
perithelioma of, 358
polycystic degeneration of, 367
position of, 177
primary new growths of, 373
tumors of, 349, 372
method of growth, 352
treatment of, 353
results of operation, 353
relations of, 179
of colon to, 180
resection of, 410
rupture of, 232
sarcoma of, 358
suppurative dilatations of, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrecotomy, 290
syphilis of, 347
traumatism of, hemorrhage from, 342
tuberculosis of, 316
from bladder, 322
cystoscopic examination of, 326
diagnosis of, 327
symptoms of, 324
treatment of, 328
nephrectomy in, 329
nephrotomy in, 329
results of operation, 333
tumors of, 349
benign, 353

Kidneys, tumors of, cystic, 366
hemorrhage due to, 351
malignant, 355
retention, 258
thrombosis from, 352
treatment of, 353
nephrectomy in, 353
ureteral catheterization through, 312
vessels of, ligation of, 400
wounds of, gunshot, 242
prognosis of, 243
treatment of, 243
incised, 241
stab-, 241
Kollmann's urethrometer and dilator, 604
urethrotome, 611
König's incision in lumbar nephrectomy, 398
Kraske's resection of rectum, 159

LACERATIONS of corpora cavernosa, 632
of urethra, 589
complications of, 592
diagnosis of, 593
etiology of, 590
pathological anatomy of, 590
prognosis of, 593
symptoms of, 591
treatment of, 593
Langenbeck's pile-clamp, 133
Le Fort's operation for exstrophy of bladder, 433
Leprosy of testicle, 707
Leroy's prostatic catheter, 551
Ligation of common iliac artery, 75
of external iliac artery, 75
of inferior gluteal artery, 75
of internal iliac artery, 75
pudic artery, 75
of pelvic arteries, 73
of superior gluteal artery, 75
of vessels of kidney, 400
Ligature-carrier, 135
Lipoma of kidney, 353
of pelvis, 20
of scrotum, 666
of spermatic cord, 687
of testicle, 687
of tunica vaginalis, 687
Liston's catheter for hypertrophy of prostate, 551
Lithotomy, lateral perineal, in treatment of vesical calculi, 511
Lithotrites, types of, 515
Lithotrity, evacuation pump for use in, 518
in treatment of vesical calculi, 514
Luy's urine segregator, 208
Lymphangioma of pelvis, 20

MALFORMATIONS, congenital, of anus, 83
of pelvis, 17
Malformations, congenital, of rectum, 83
of urethra, 569
Maydl's operation for exstrophy of bladder, 444
Membranous cystitis, 476
Meningoceles associated with lymphangiomata, 20
with teratomata, 20
pure, 20
sacrococcygeal, 17
sacrolumbar, 17
Mercier's catheter for prostatic hypertrophy, 551
Miliano's varicocele compressor, 690
Morgagni, hydatid of, cysts of, 707
Morris' endoscopic tube, 200
Movable kidney, 245
and appendicitis, 250
decortication of, 253
diagnosis of, 245
etiology of, 245
fixation of, 252
hemorrhage from, 341
suture of, results of, 257
treatment of, 251
uronephrosis in, 264
Mucous polyps of rectum, 146
diagnosis of, 147
symptoms of, 146
treatment of, 147
Multilocular cystoma, 710
hydrocele of spermatic cord, 686
treatment of, 686
spermatocele, 709
Multiple villous papilloma of bladder, 522
Myeloceles associated with cavernous tumors, 20
with cystic lymphangioma, 20
with lipoma, 20
pure, 20
Myoma of bladder, 524
Myxoma of bladder, 524

NÉLATON'S prepuce dilator, 629
Nephrectomy, 394
changes in remaining kidney after, 410
clinical results of, 406
for calculi of kidney, 315
lumbar method, 394
Bardenheuer's incision, 398
Bean's incision, 396
Bergmann's incision, 397
D'Antona's incision, 397
Guyon's incision, 395
König's incision, 398
Simon's incision, 394
mortality of, 405
in suppurative nephritis, 291
transperitoneal method, 403
in tuberculosis of kidney, 329
in tumors of kidney, 353
in two steps, 406
in uronephrosis, 282

Nephritis, suppurative, 283, 287
cystoscopic examination in, 289
diagnosis of, 288
due to renal colic, 346
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrectomy in, 291
nephrotomy, 299
partial nephrectomy, 290
Nephrolithiasis, 293
Nephropexy, 252
Nephrotomy in calculi of kidney, 399
in hemorrhage of kidney, 343
in tuberculosis of kidney, 329
in uronephrosis, 276
Neuralgia, renal, 344
treatment of, 345
Nitze's bladder forceps with electric lamp, 534
operating cystoscope, 531

OCCLUSION of rectum combined with fistula, 90
complete, without fistula, 87
Orchitis, acute, 697
diagnosis of, 698
prognosis of, 698
symptoms of, 698
treatment of, 698
chronic, 699
compressor, 699
Organic strictures of urethra, 599
Osteoma of testicle, 715
Osteomyelitis of pelvis, acute, 45
diagnosis of, 47
symptoms of, 46
treatment of, 48, 61
Otis' evacuator, 520
urethrometer, 604

PAPILLOMA of bladder, benign, cystophotographs of, 528
mutiple villous, 523
solitary, 523
of penis, 644
of rectum, 148
symptoms of, 148
treatment of, 148
of urethra, 622
Paranephritic cysts of kidney, 372
Paraphimosis, 639
Pawlik's ureteral catheterization, 196
Pelvirectal abscess, 110
Pelvis, arteries of, aneurism of, 59
ligation of, 73
bones of, fracture of, 23
diagnosis of, 31
prognosis of, 35
symptoms of, 31
treatment of, 36
syphilis of, treatment of, 55
tuberculosis of, 50
diagnosis of, 52
treatment of, 52
Pelvis, congenital malformations of, 17
crushes of, 38
treatment of, 39
diseases of, 17–45
dislocation of, 38
one-half of, 38
prognosis of, 38
echinococcus of, 71
prognosis of, 72
symptoms of, 72
treatment of, 72
inflammatory infections of, 45
injuries of, 17–23
joints of, tuberculosis of, 50
diagnosis of, 52
treatment of, 52
of kidney, primary new growths of, 373
tumors of, 349
method of growth, 352
treatment of, 353
results of operation, 353
lipoma of, 20
lymphangioma of, 20
new growths of, 63
operations on, 73
renal, tumors of, 373
suppuration of, 55
treatment of, 58
teratoma of, 20
wounds of, 39
gunshot, 40
anterior portion of, 41
prognosis of, 41
complications of, 42
treatment of, 42
stab-, 39
Penile hypospadias, 583
Penis, absence of, partial, 625
total, 627
amputation of, 651
angioma of, 645
carcinoma of, 646
diagnosis of, 650
etiology of, 647
prognosis of, 650
treatment of, 651
ulcer due to, 650
cellulitis of, 640
congenital anomalies of, 625
constriction of, 632
cysts of, 643
diseases of, exclusive of venereal diseases, 637
dislocation of, 634
divided, 625
double, 625
elephantiasis of, 642
erysipelas of, 641
fracture of, 631
inflammation of, 637
injuries of, 631
subcutaneous, 631
papilloma of, 644
sarcoma of, 645

Penis, tuberculosis of, 643
tumors of, 643
warts of, 644
wounds of, 634
bullet, 636
incised, 634
punctured, 634
Pericystitis, cystitis following, 483
Perinephritic abscess, 336
tubercular, 320
Perinephritis, 333
diagnosis of, 338
etiology of, 334
prognosis of, 339
symptoms of, 337
treatment of, 339
Perineum, wounds of, 40
Periorchitis, acute serous, 670
adhesive, 684
chronic serous, 673
diagnosis of, 676
pathological anatomy of, 673
prognosis of, 679
symptoms of, 675
treatment of, 679
hemorrhagic, 682
treatment of, 684
proliferative, 684
purulent, 672
treatment of, 672
serofibrinous, acute, 670
symptoms of, 670
treatment of, 672
Periproctal connective tissue, inflammations in, 106
etiology of, 106
pathological anatomy of, 107
treatment of, 110
Perispermatitis, acute serous, 672
symptoms of, 672
chronic serous, symptoms of, 684
treatment of, 685
hemorrhagic, 685
prognosis of, 686
treatment of, 686
Perithelioma of kidney, 358
Peritonitis, urinary infiltration causing, 452
Periureteritis, 390
Pessary, dumb-bell, 131
Phimosis, acquired, 638
congenital, 626
symptoms of, 627
treatment of, 628
operations for, 629
producing hydrocele, 628
nocturnal incontinence, 624
scissors, 629
Phosphates, vesical calculi composed of, 502
Pile-clamps, 133
Polycystic degeneration of kidney, 367
Polyposis recti, 147
Polyps, mucous, of rectum, 146
Polyps, mucous, of rectum, diagnosis of, 147
symptoms of, 146
treatment of, 147
of urethra, 622
Pregnancy, hemorrhage in, 341
Prepuce dilator, 629
Proctitis, simple, of rectum, 98
etiology of, 98
pathological anatomy of, 98
symptoms of, 99
treatment of, 99
Proctoscope, Kelly's, 80
Simon's, 80
Tuttle's, 80
Proctotomy, external, 122
internal, 122
Prolapse of anus, 136
etiology of, 137
pathological anatomy of, 136
symptoms of, 138
treatment of, 139
of bladder, 464
of rectum, 136
causes of, 137
cauterization of, 139
in children, 139
etiology of, 137
operation for, 140
symptoms of, 138
treatment of, 139
of testicle, 661
vesical, 464
Prolapsus recti, 147
pathological anatomy of, 147
prognosis of, 147
symptoms of, 147
treatment of, 148
Proliferative periorchitis, 684
Prostate gland, anatomy of, 539
anomalies of, 541
calculi of, 561
carcinoma of, 563
cysts of, 564
diseases of, 539
examination of, 546
fibroma of, 562
function of, 541
hypertrophy of, 545
catheters for, 551
cystitis due to, 497
diagnosis of, 550
etiology of, 549
excentric, 548
false passage in, 553
removal of vas deferens for, 560
stages of, 549
symptoms of, 549
treatment of, 550
castration in, 559
prostatectomy, 556
prostatotomy, 556
sexual operations for, 559

Prostate gland, hypertrophy of, treatment of, suprapubic cystotomy, 555
urine in, 555
inflammation of, 542
prognosis of, 543
symptoms of, 543
treatment of, 544
injuries of, 542
sarcoma of, 562
stricture of, cystitis due to, 497
syphilis of, 545
tuberculosis of, 545
tumors of, 562
Prostatectomy in treatment of hypertrophy of prostate, 556
Prostatic calculi, 561
incisor, 557
Prostatitis, acute, 542
chronic, 543
treatment of, 544
Prostatotomy in treatment of hypertrophy of prostate, 556
Pruritus ani, 97
symptoms of, 97
treatment of, 97
Pudic artery, internal, ligation of, 75
Purulent periorchitis, 672
treatment of, 672
Pyelitis, 283
diagnosis of, 288
pathological anatomy of, 285
suppurative, 287
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
Pyelostomy, 415
Pyonephrosis, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290

RECTAL bougies, Créde's, 121
specula, Weiss', 81
Rectocolonic speculum, Bodenhammer's, 79
Rectopexy, 142
Rectum, adenoids of, 146
diagnosis of, 147
symptoms of, 146
treatment of, 147
anatomy of, 77
atresia of, 83
carcinoma of, 144, 148
after-treatment of, 168
diagnosis of, 153
etiology of, 152
inoperable, 173
pathological anatomy of, 141
prognosis of, 168
symptoms of, 152
Rectum, carcinoma of, treatment of, 154
choice of operation, 163
functional results of, 170
inoperable, 173
methods of operation, 156
abdominal, 166
circular incision, 156
dorsal, 159
partial excision, 156
perineal, 157
vaginal, 166
preparation of patient, 155
radical operation, indications for, 154
late results of, 172
chancroid of, 101
congenital fistula of, 86
malformations of, 83
dilating bougies for, 122
diseases of, 97
examination of, 78
foreign bodies in, 94
diagnosis of, 95
injections for, 95
symptoms of, 94
treatment of, 95
hemorrhage from, 92
inflammations of, 97
gonorrhœal, 99
etiology of, 99
prognosis of, 101
symptoms of, 99
treatment of, 101
injuries of, 92
etiology of, 92
symptoms of, 92
treatment of, 93
with infection, 92
irrigation of, in proctitis, 99
mucous polyps of, 146
diagnosis of, 147
symptoms of, 146
treatment of, 147
occlusion of, combined with fistula, 30
complete without fistula, 87
papilloma of, 148
symptoms of, 148
treatment of, 148
proctitis of, simple, 98
etiology of, 98
pathological anatomy of, 98
symptoms of, 99
treatment of, 99
prolapse of, 136
cauterization of, 139
in children, 139
etiology of, 137
operation for, 140
pathological anatomy of, 136
symptoms of, 138
treatment of, 139
resection of, 147

Rectum, resection of, abdominal, 166
Kraske's, 159
mortality after, 168
stricture of, 118
chronic rectal catarrh from, 120
diagnosis of, 120
dilatation of, 124
extirpation of, 123
pathology of, 119
symptoms of, 120
treatment of, 120
suppuration about, 106
syphilitic affections of, 101
prognosis of, 103
symptoms of, 102
treatment of, 103
tuberculosis of, 103
treatment of, 104
tumors of, 144
benign, developing from connective tissue, 145
from epithelial portion of rectum, 146
malignant epithelial growths, 148
ulcers of, 98
gonorrhœal, 99
etiology of, 99
prognosis of, 101
symptoms of, 99
treatment of, 101
ureters transplanted in, 443
used as bladder, 442
Renal arteries, aneurisms of, 373
treatment of, 374
colic, 346
due to nephritis, 346
disease, examination of urine in, 193
hæmophilia, 342
hemorrhage, 329
essential, 340
diagnosis of, 343
treatment of, 343
neuralgia, 344
treatment of, 345
pelvis, tumors of, 373
Resection of bladder for tumors, 534
of kidney, 410
of rectum, 141
abdominal, 166
Kraske's, 159
mortality after, 168
of scrotum, for varicocele, 691
of ureter, 383
Retention tumors of kidney, 258
Roux's operation for exstrophy of bladder, 431
Rupprecht's catheter sterilizer, 486
Rupture of bladder, 447
diagnosis of, 450
intraperitoneal, 451
operation for, 453
symptoms of, 449
through external wound, 454
treatment of, 452
Rupture of urethra, 589
treatment of, 593

SACROCOCCYGEAL meningocele, 17
tumors, 20
Sacrolumbar hypertrichoses and spina bifida occulata, 20
meningocele, 17
tumors, 20
Sacrum, dislocation of, with involvement of both sacro-iliac joints, 38
fracture of, 27
tumors of, 20
on anterior surface of, 20
causes of, 18
congenital, 17
diagnosis of, 20
on dorsum of, 20
treatment of, 21
Sarcoma of bladder, 524
of kidney, 358
of penis, 645
of prostate gland, 562
of scrotum, 666
of spermatic cord, 687
of testicle, 687, 713
diagnosis of, 714
etiology of, 714
of tunica vaginalis, 687
Scrotal hypospadias, 584
diagnosis of, 584
etiology of, 584
pathogenesis of, 584
prognosis of, 585
symptoms of, 584
treatment of, 585
Scrotum, congenital anomalies of, 653
carcinoma of, 666
cysts of, 666
dermoid, 666
sebaceous, 666
diseases of, 661
elephantiasis of, 663
erysipelas of, 662
gangrene of, 662
inflammation of, 661
injuries of, 660
lipoma of, 666
resection of, for varicocele, 691
sarcoma of, 666
tumors of, 663
benign, 666
malignant, 666
wounds of, 661
Sebaceous cysts of scrotum, 666
Segond's operation for exstrophy of bladder, 433
Seminal vesicles, calculi of, 719
diseases of, 718
excision of, 720
inflammations of, 719
tuberculosis of, 719
tumors of, 720
Serofibrinous periorchitis, acute, 670
symptoms of, 670

Serofibrinous periorchitis, treatment of, 672
Serous periorchitis, chronic, 673
diagnosis of, 676
pathological anatomy of, 673
prognosis of, 679
symptoms of, 675
treatment of, 679
perispermatitis, acute, 672
symptoms of, 672
chronic, symptoms of, 685
treatment of, 685
Simon's hard rubber urethral speculum, 195
incision in lumbar nephrectomy, 394
proctoscope, 80
urethral catheterization, 196
specula, 426
Solitary papilloma of bladder, 523
Spastic strictures of urethra, 599
Specula, rectal, Weiss', 81
Speculum, rectocolonic, Bodenhammer's, 79
urethral, 195
Spermatic cord, diseases of, 668
fibroma of, 687
hæmatocele of, acute, 682
treatment of, 684
chronic, 685
prognosis of, 686
treatment of, 686
complications of, 686
hæmatoma of, 668
hydrocele of, acute, 672
symptoms of, 672
bilocular, 676
chronic, 673
diagnosis of, 676
pathological anatomy of, 673
prognosis of, 679
symptoms of, 675, 685
treatment of, 679, 685
complications of, 686
congenital, 676
diffuse, 686
multilocular, 686
treatment of, 686
lipoma of, 687
membranes of, inflammations of, acute, 670
chronic, 673
injuries of, 668
tumors of, 687
sarcoma of, 687
Spermatocele, 708
diagnosis of, 711
due to torsion of vas deferens, 712
etiology of, 710
intravaginal, 711
multilocular, 709
treatment of, 711
Sphincterotomy, posterior, 82
Spina bifida, 20
Stab-wounds of gluteal artery, 39
of pelvis, 39
Stone-searcher, Guyon's, 422
Thompson's 422
Stricture of anus, 117
etiology of, 117
treatment of, 118
of prostate, cystitis due to, 497
of rectum proper, 118
diagnosis of, 120
dilatation of, 124
extirpation of, 123
pathology of, 119
symptoms of, 120
treatment of, 120
of urethra, 599
congenital, 571
diagnosis of, 605
electrolysis for, 610
excision of, 613
inflammatory, 599
organic, 599
prognosis of, 606
spastic, 599
symptoms of, 601
treatment of, 606
Suppuration of Cowper's glands, 624
Suppurative cystitis, 481
dilatation of kidney, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
inflammations of kidney, 283
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
of rectum, 106
nephritis, 283
cystoscopic examination in, 289
diagnosis of, 288
pathological anatomy of, 285
symptoms of, 284, 287
treatment of, 290
nephrotomy, 290
partial nephrectomy, 290
pyelitis, 287
Suprapubic cystotomy, 489
in treatment of hypertrophy of prostate, 555
of vesical calculi, 511
Suprarenal gland, diseases of, 417
function of, 416
tuberculosis of, 417
tumors of, 417
Syphilis of kidney, 347
of pelvic bones, 55

Syphilis of pelvic bones, treatment of, 55
of prostate, 545
of testicle, 705
diagnosis of, 707
etiology of, 706
pathological anatomy of, 706
prognosis of, 707
treatment of, 707
Syphilitic affections of anus, 101
prognosis of, 103
symptoms of, 102
treatment of, 103
of rectum, 101
prognosis of, 103
symptoms of, 102
treatment of, 103

TAYLOR'S phimosis scissors, 629
Tenesmus due to calculi of bladder, 506
Teratoma, cystic, of kidney, 372
of pelvis, 20
of testicle, 716
Testicle, actinomycosis of, 707
adenoma of, 716
carcinoma of, 715
contusions of, 693
diagnosis of, 693
symptoms of, 693
treatment of, 693
coverings of, diseases of, 668
cysts of, 707
dermoid, 716
diseases of, 693
dislocation of, 693
enchondroma of, 714
fibroma of, 714
hæmatomā of, 668
inflammation of, acute, 694
injuries of, 693
leprosy of, 707
lipoma of, 714
membranes of, tumors of, 687
osteoma of, 715
prolapse of, 661
sarcoma of, 687, 713
diagnosis of, 714
etiology of, 714
syphilis of, 705
diagnosis of, 707
etiology of, 706
pathological anatomy of, 706
prognosis of, 707
treatment of, 707
teratoma of, 716
tuberculosis of, 699
etiology of, 701
pathological anatomy of, 700
prognosis of, 703
treatment of, 703
tumors of, benign connective tissue, 714
epithelial, 715
solid, 712
undescended, 653
Testicle, undescended, results of, 654
abnormal mobility, 655
atrophy, 654
misplaced testicle, 657
twisting of testicle, 655
symptoms of, 654
treatment of, 657
wounds of, 694
Thiersch's operation for epispadias, 578
Thompson's catheter for prostatic hypertrophy, 551
forceps for removing vesical growths, 533
stone-searcher, 422
urethrotome, 611
Thrombosis of kidney from tumors, 352
Torsion of vas deferens, spermatocele due to, 712
Traumatic cystitis, 471
fistula of bladder, 456
uronephrosis, 263
diagnosis of, 273
symptoms of, 271
treatment of, 274
Traumatism of kidney, hemorrhage from, 342
Tubercular perinephritic abscess, 320
Tuberculosis of anus, 103
treatment of, 104
of bones of pelvis, 50
diagnosis of, 52
treatment of, 52
of epididymis, 699
etiology of, 701
pathological anatomy of, 700
prognosis of, 703
treatment of, 703
of joints of pelvis, 50
diagnosis of, 52
treatment of, 52
of kidney, 316
from bladder, 322
cystoscopic examination in, 326
diagnosis of, 327
symptoms of, 324
treatment of, 328
nephrectomy in, 329
nephrotomy in, 329
results of operation, 333
urine in, 325
of penis, 643
of prostate, 545
of rectum, 103
treatment of, 104
of seminal vesicles, 719
of suprarenal glands, 417
of testicle, 699
etiology of, 701
pathological anatomy of, 700
prognosis of, 703
treatment of, 703
of ureter, 322
of urethra, 621
treatment of, 622
Tuberculous cystitis, 495

Tuberculous fistula in ano, 116
Tumors of anus, 144
benign, 144
treatment of, 144
malignant, 144
prognosis of, 145
symptoms of, 145
treatment of, 145
of bladder, 521
catarrh from, 526
cystitis due to, 499
diagnosis of, 527
etiology of, 525
hemorrhage from, 525
involving ureter, 535
pathological anatomy of, 521
removed through cystoscope, 530
resection for, 534
symptoms of, 525
treatment of, 529
of coccyx, 20
dorsum of, 20
causes of, 18
diagnosis of, 20
treatment of, 21
of kidney, 349
benign, 353
cortex of, 364
cystic, 366
hemorrhage due to, 351
malignant, 355
pelvis of, 349
method of growth, 352
treatment of, 353
results of operation, 353
retention, 258
thrombosis from, 352
treatment of, 353
nephrectomy in, 353
of penis, 643
of prostate gland, 562
of rectum, 144
benign, developing from connective tissue, 145
from epithelial portion of rectum, 146
malignant epithelial growths, 148
of renal pelvis, 373
sacrococcygeal, 20
sacrolumbar, 20
of sacrum, 20
anterior surface of, 20
congenital, 17
dorsum of, 20
of scrotum, 663
benign, 666
malignant, 666
of seminal vesicles, 720
of spermatic cord, membranes of, 687
of suprarenal glands, 417
of testicle, benign connective tissue, 714
epithelial, 715
Tumors of testicle, membranes of, 687
solid, 712
of ureter, 391
of urethra, 622
benign, 622
malignant, 622
treatment of, 623
Tunica vaginalis, fibroma of, 687
hemorrhage into, 669
inflammation of, 670
injury of, 668
lipoma of, 687
sarcoma of, 687
Tuttle's proctoscope, 80

ULCERS of penis, due to carcinoma, 650
of rectum, 98
etiology of, 98
gonorrhœal, 99
etiology of, 99
prognosis of, 101
symptoms of, 99
treatment of, 101
pathological anatomy of, 98
symptoms of, 99
treatment of, 99
Ulcus molle, 101
Undescended testicle, 653
cancer in, 658
results of, 654
atrophy, 654
abnormal mobility, 655
misplaced testicle, 657
twisting of testicle, 655
symptoms of, 654
treatment of, 657
Urachal fistula, 428
Urates, vesical calculi composed of, 502
Ureteral catheterization, 195
Kelly's, 196
Pawlik's, 196
Simon's, 196
cystoscope, 203
Ureteritis, 389
Ureters, absence of, 220
anatomical characteristics of, 181
blood-clots in, 193
catheterization of, 195
congenital abnormalities of, 221
cystic dilatation of, 227
cysts of, 391
development of, 222
diseases of, 389
double, 225
examination of, 186
fistula of, 378
operation for, 379
protection during, 380
impacted calculi of, 387
implantation of, 384
incision of, for calculi of kidney, 315
inflammations of, 389
injuries of, 375
anatomy of, 375

Ureters, injuries of, prognosis of, 376
treatment of, 381
misplacements of, 392
openings of, abnormal, 225
operations on, 393
palpation of, 375
relations of, 181
removal of, for tuberculosis, 332
resection of, 383
suture of, 381
transplanted in rectum, 443
tuberculosis of, 322
tumors of, 391
of bladder involving, 535
Urethra, absence of, 570
calculi in, 619
of bladder and, 506
diagnosis of, 620
prognosis of, 620
symptoms of, 619
treatment of, 620
carcinoma of, 622
treatment of, 623
cauterization of, 610
congenital malformations of, 569
constrictions of, 570
dilatation of, 570, 606
diseases of, exclusive of venereal diseases, 621
diverticulum of, 572
double, 570
examination of, 565
fistulas of, 614
diagnosis of, 615
prognosis of, 615
treatment of, 615
foreign bodies in, 616
diagnosis of, 617
prognosis of, 618
symptoms of, 617
treatment of, 618
injuries of, 589
lacerations of, 589
complications of, 592
diagnosis of, 593
etiology of, 590
pathological anatomy of, 590
prognosis of, 593
symptoms of, 591
treatment of, 593
obliteration of, 570
papilloma of, 622
partial closure of, 570
polyps of, 622
rupture of, 589
treatment of, 593
urinary infiltration in, 592
strictures of, 599
congenital, 571
diagnosis of, 605
electrolysis in, 610
excision of, 613
inflammatory, 599
organic, 599
prognosis of, 606
Urethra, strictures of, spastic, 599
symptoms of, 601
treatment of, 606
suture of, 598
tuberculosis of, 621
treatment of, 622
tumors of, 622
benign, 622
malignant, 622
treatment of, 623
Urethral endoscope, 565
fever, 568
openings, abnormal, 225
diagnosis of, 227
treatment of, 228
specula, Simon's, 426
speculum, 195
Urethrometer, 604
and dilator, 604
Urethrotomes, Fessenden-Otis, 611
Kollmann's, 611
Thompson's, 611
Urethrotomy, 597
external, 611
internal, 610
Uric acid, vesical calculi composed of, 502
Urinary fistulas, following injuries of bladder, 456
treatment of, 457
infiltration, causing peritonitis, 452
in rupture of urethra, 592
sediments in cystitis, 480
Urine, in calculi of bladder, 506
of kidney, 299
in cystitis, 477
three-glass test for, 478
examination of, in renal disease, 193
in hypertrophy of prostate, 555
residual, 548
segregator, Cathelin's, 209
Harris', 206
Luys', 208
Morris', 200
Roses', 199
in tuberculosis of kidney, 325
in uronephrosis, 272
Uronephrosis, 261
hemorrhage in, 341
traumatic, 263
causes of, 270
complete, 266
diagnosis of, 273
displacement of ureter in, 268
incomplete, 266
intermittent, 276
in movable kidney, 264
symptoms of, 271
treatment of, 274
incision of sac, 276
nephrectomy in, risk of, 282
nephrotomy in, 276
renal fistula after, 277
plastic operation, 277
puncture of sac, 274

Uronephrosis, traumatic, treatment of, removal of sac, 281
urine in, 272

VAGINAL cystocele, 469
diagnosis of, 470
etiology of, 469
pathological anatomy of, 469
prognosis of, 470
symptoms of, 470
Varicocele, 687
clamp, 690
compressor, 690
etiology of, 688
pathology of, 688
resection of scrotum for, 691
symptoms of, 688
treatment of, 690
Vas deferens, removal of, for hypertrophy of prostate, 560
torsion of, spermatocele due to, 712
Vasectomy, 560
Vesical calculi, 499
composed of phosphates, 502
of urates, 502
of uric acid, 502
of calcium oxalate, 503
of cystin, 503
cystophotographs of, 510
diagnosis of, 507
facetted, 505
and phosphatic crusts with chronic cystitis, 504
prognosis of, 509
symptoms of, 505
treatment of, 510
Vesical calculi, treatment of, lateral perineal lithotomy, 511
lithotomy in women, 514
lithotrity, 514
suprapubic cystotomy, 511
growths, forceps for removing, 533
hernia, 464
etiology of, 467
symptoms of, 467
treatment of, 468
irritation due to calculi of kidney, 303
prolapse, 464
Vessels of kidney, ligation of, 400
Virga palmata, 583

WARTS of penis, 644
Weiss' rectal specula, 81
Wood's operation for exstrophy of bladder, 432
Wounds of bladder, perforating, 455
of kidney, gunshot, 242
prognosis of, 243
treatment of, 243
incised, 241
stab-, 241
of pelvis, gunshot, 40
stab-, 39
of penis, 634
bullet, 636
incised, 634
punctured, 634
of perineum, 40
of scrotum, 661
of testicle, 694

X-RAY in demonstration of calculi of kidney, 306

GENERAL INDEX.

[The small numeral letters preceding the figures indicate the volume to which reference is made.]

ABDOMEN, distention of, in intestinal obstruction from gall-stones, iv. 344
injuries of, subcutaneous, iv. 157
wounds of, punctured, iv. 125
Abdominal hemorrhage, iv. 156
incision for gangrenous intestine, iv. 540
in laparotomy, iv. 205
operations, iv. 481
pain from thrombosis of mesentery, iv. 329
resection of rectum, v. 166
scars, hernia in, iv. 614
tumors, iv. 239
wall, actinomycosis of, iv. 132
carcinoma of, iv. 137
contusions of, iv. 124
diseases of, iv. 129
echinococcus of, iv. 137
elephantiasis of, iv. 141
epithelioma of, iv. 137
fatty overgrowths of, iv. 141
fibroma of, iv. 133
foreign bodies in, iv. 127
inflammations of, iv. 129
injuries of, iv. 123
lipoma of, iv. 133
pendulous, iv. 139
sarcoma of, iv. 133
tumors of, iv. 133
wounds of, closure of, iv. 480
Abducens nerve, injuries of, i. 237
Abnormal urethral openings, v. 225
Abnormalities, congenital, of bladder, v. 428
of kidney, v. 218
of ureters, v. 221
Abrachia, iii. 117
Abscess about anus, v. 108
at angles of jaw, ii. 83
in appendicitis, iv. 357
from appendix, iv. 354
of axilla, iii. 80
of brain, i. 275
cerebral, acute traumatic, i. 277
chronic traumatic, i. 278
following caries of skull, i. 288
osteomyelitis, i. 288
ulcer of skull, i. 288
metastatic, i, 289
of nasal origin, i. 287
otitic, i. 282
of chest-wall, ii. 454
complicating salivary calculus, i. 621
Abscess, cortical, acute traumatic, i. 250
extradural, complicating otitis media, i. 376
of face, i. 481
following cephalhæmatoma in newborn, i. 21
from hydatid cyst of liver, iv. 648
ischiorectal, v. 107
of kidney, v. 258
of liver, iv. 639
of lungs, ii. 506
of muscles of upper arm, iii. 144
of neck, ii. 76
branchiogenic, ii. 123
tuberculous, ii. 85
of pancreas, iv. 724
pelvirectal, v. 110
perinephritic, v. 336
tubercular, v. 320
peripleuritic, ii. 454
peritonsillar, i. 886
of popliteal space, iii. 654
retropharyngeal, i. 890
of septum of nose, i. 750
of spleen, iv. 703
of stomach, iv. 315
subperiosteal tuberculous, i. 159
subphrenic, iv. 184
of supraclavicular fossa, ii. 84
of tongue, chronic, i. 840
of vascular space, ii. 83
Absence of urethra, v. 570
Accessory goitre, ii. 310
thyroid gland, i. 910; ii. 312
Accident and judgment, iii. 263
Acetabulum, fracture of, v. 26
Achondroplasia, i. 129
Acinous carcinoma of mammary gland, ii. 585
Acromegaly of hand, iii. 351
Acromial bursitis, iii. 78
Actinomycosis of abdominal wall, iv. 132
of breast, ii. 575
of ear, i. 386
of face, i. 491
of intestine, iv. 525
of jaws, i. 673
of kidney, v. 348
of larynx, ii. 209
of lung, ii. 522
of mouth, i. 830
of neck, ii. 86
of œsophagus, iv. 64
of peritoneum, iv. 196

Actinomycosis of salivary glands, i. 633
of spine, ii. 755
of submaxillary region, i. 492
of temporomaxillary region, i. 492
of testicle, v. 707
of thoracic wall, ii. 458
of thyroid gland, ii. 346
of tongue, i. 831
Addison's disease, v. 416
Adenitis of axilla, iii. 80
cubital, iii. 143
inguinal, iii. 522
tuberculous, of face, i. 490
Adenocystoma of kidney, v. 368
Adenoids of pharyngeal tonsil, i. 778
of rectum, v. 146
Adenoma of bladder, v. 523
of ear, i. 390
of intestine, iv. 385
of kidney, v. 353
of liver, iv. 635
of mammary gland, ii. 580
of nasopharynx, i. 795
of salivary gland, i. 650
of sebaceous glands, i. 522
of stomach, iv. 369
of testicle, v. 716
of tongue, i. 858
Adenosarcoma, embryonic, of kidney, v. 360
Adhesions in appendicitis, iv. 368
at boundary of mesopharynx and epipharynx, i. 303
of gall-bladder, iv. 680
of stomach, separation of, iv. 411
from ulcer of stomach, iv. 311
Adhesive periorchitis, v. 684
peritonitis, chronic, iv. 191
Adiamorrhysis, i. 190
Aërocele, ii. 147
Agraphia, i. 259
Ainhum, iii. 774
Air-passages, burns of, ii. 162
foreign bodies in, ii. 163
operations on, ii. 250
Albarran's ureter cystoscope, v. 201
Albert's method of suture of intestine, iv. 398
Alexia, i. 259
Allingham's ligature-carrier, v. 135
Aluminum acetate for ulcers of leg, iii. 686
Alveolar process, tumors of, i. 693
Amelia, iii. 117
Amputations of ankle, iii. 873
of arm, spontaneous, iii. 117
upper, iii. 158
of elbow-joint, iii. 226
of fingers, iii. 378
phalanges of, iii. 379
of forearm, iii. 259
of hand, iii. 377
of hip-joint, iii. 527
at knee, iii. 713
of leg, iii. 713
Amputations, Malgaigne's, iii. 876
at mediotarsal joint, Chopart's, iii. 877
of metacarpals, iii. 377
of metatarsals, iii. 879
of penis, v. 651
Pirogoff's osteoplastic, iii. 873
of shoulder, iii. 108
interscapulothoracic, iii. 112
of single metatarsals and toes, iii. 879
subastragaloid, iii. 876
Syme's, iii. 873
Textor's, iii. 877
of thigh, iii. 562
through metatarsals, iii. 879
tarsometatarsal joints, iii. 879
of toes, iii. 880
Anæmia from ulcer of stomach, iv. 309
Anastomosis, intestinal, iv. 542
Aneurism of aorta, ii. 455
of arteries of scalp, i. 52
arteriovenous, of scalp, i. 52
of axilla, iii. 81
of brachial artery, iii. 145
cirsoid, i. 50
of hand, iii. 368
of face, i. 515
of femoral artery, iii. 549
of foot, iii. 862
gluteal, v. 61
of hepatic artery, iv. 657
of humerus, iii. 151
inguinal, v. 59
of leg, iii. 689
of neck, ii. 66
arterial, ii. 66
of common carotid, ii. 66
of external carotid, ii. 70
of innominate, ii. 70
of internal carotid, ii. 70
of subclavian above collar-bone, ii. 72
of vertebral artery, ii. 72
arteriovenous, ii. 73
of common carotid and internal jugular, ii. 75
of external carotid and internal jugular, ii. 75
extracranial, of internal carotid, ii. 75
of subclavian vessels, ii. 75
traumatic, ii. 66
of pelvic arteries, v. 59
popliteal, iii. 654
racemose, of pharynx, i. 908
of renal arteries, v. 373
of thigh, iii. 549
of thoracic aorta, ii. 541
Angina, acute, i. 880
Angioma arteriale racemosum, i. 49
of ear, i. 388
of face, i. 511
of foot, iii. 870
of mammary glands, ii. 580
of mouth, i. 840

Angioma of muscles of upper arm, iii. 144
of neck, cavernous, ii. 130
simplex, ii. 130
of penis, v. 645
of pharynx, i. 908
racemose arterial, i. 49
of salivary glands, i. 643
of scalp, cavernous, i. 47
simplex, i. 45
of tongue, i. 840
Angioneurotic hemorrhage, v. 342
Angiosarcoma of kidney, v. 358
Ankle, disease of, iii. 773
inflammations of, iii. 773
-joint, amputation of, iii. 873
inflammations of, iii. 781
injuries of, iii. 728, 766
resection of, iii. 880
sprains of, iii. 728
synovitis of, iii. 781
tabetic disease of, iii. 869
skin of, tuberculosis of, iii. 774
Ankylosis of hand, iii. 356
of hip-joint, iii. 501
of jaw, inflammatory, i. 715
of knee-joint, iii. 626
of shoulder-joint, iii. 98
Anomalies, congenital, of intestine, iv. 249
of penis, v. 625
of scrotum, v. 653
Anthrax of face, i. 498
Anuria due to calculi of kidney, v. 302
after renal injury, v. 236
Anus, abscess about, v. 108
artificial, iv. 459, 546
congenital malformations of, v. 83
diseases of, v. 97
fissure of, v. 104
furunculosis of, v. 98
imperforate, v. 83
prolapse of, v. 136
stricture of, v. 117
syphilitic affections of, v. 101
tuberculosis of, v. 103
tumors of, v. 144
benign, v. 144
malignant, v. 144
Aorta, thoracic, aneurism of, ii. 541
Aphasia, i. 259
in cerebral hemorrhage, i. 215
in subdural hemorrhage, i. 229
Apoplexies, late traumatic, Bollinger's, i. 244
Appendicitis, iv. 349
and movable kidney, v. 250
Appendix, abscess of, iv. 354
empyema of, iv. 352
fistula of, iv. 354
foreign bodies in, iv. 351
gangrene of, iv. 353
inflammation of, iv. 350
obstruction of, iv. 351
perforation of, iv. 352
peritonitis from, iv. 179, 353
suppuration in, iv. 352
Arches of vertebræ, isolated fractures of, ii. 683
Areola, diseases of, ii. 564
Arm, erysipelas of, iii. 143
malignant œdema of, iii. 143
phlegmonous processes of, iii. 143
upper, amputation of, iii. 158
evulsion of, iii. 141
injuries of, gunshot, iii. 139
malformations of, iii. 117
muscles of, abscess of, iii. 144
angioma of, iii. 144
diseases of, iii. 144
gumma of, iii. 144
hernia of, iii. 119
injuries of, iii. 118
ossification of, iii. 144
rupture of, iii. 119
wounds of, iii. 118
nerves of, diseases of, iii. 145
injuries of, iii. 122
neuroma of, iii. 145
operations on, iii. 156
prothesis for, iii. 159
shaft of, resection of, iii. 157
skin of, neoplasms of, iii. 144
tumors of, iii. 144
soft parts of, diseases of, iii. 143
injuries of, iii. 118
syphilitic myositis of, iii. 144
vessels of, diseases of, iii. 145
injuries of, iii. 121
wounds of, severe lacerated, iii. 141
Arteries, axillary, injuries of, iii. 20
ligation of, iii. 105
brachial, aneurism of, iii. 145
injuries of, iii. 121
ligation of, iii. 156
carotid, cerebral, injuries of, i. 231
common, arterial aneurism of, ii. 66
arteriovenous aneurisms of, ii. 73
external, arterial aneurisms of, ii. 70
arteriovenous aneurisms of, ii. 75
ligation of, in scalp-wounds, i. 35
injuries of, ii. 44
internal, arterial aneurisms of, ii. 70
arterio-aneurism of, i. 232
extracranial arteriovenous aneurisms of, ii. 75
cubital, ligation of, iii. 227
at elbow-joint, ligation of, iii. 227
femoral, aneurism of, iii. 549
injuries of, iii. 532
ligation of, iii. 559
gluteal, inferior, ligation of, v. 75
stab-wounds of, v. 39
superior, ligation of, v. 75
hepatic, aneurism of, iv. 657

Arteries, iliac, common, ligation of, v. 75
external, ligation of, v. 75
internal, ligation of, v. 75
innominate, arterial aneurisms of, ii. 70
of leg, ligation of, iii. 715
lingual, ligation of, in carcinoma of tongue, i. 869
meningeal, middle, ligation of, i. 216
in neck, injuries of, ii. 40
ligation of, ii. 44–55
occipital, ligation of, in scalp-wounds, i. 35
pelvic, aneurism of, v. 59
ligation of, v. 73
pudic, internal, ligation of, v. 75
radial, ligation of, iii. 259
at wrist, iii. 375
renal, aneurisms of, v. 373
subclavian, arterial aneurisms of, ii. 72
arteriovenous aneurisms of, ii. 75
injuries of, ii. 43; iii. 20
ligation of, iii. 22
temporal, ligation of, in scalp-wounds, i. 35
thyroid, ligation of, in treatment of goitre, ii. 339
tibial, ligation of, iii. 715, 716
ulnar, ligation of, iii. 259
at wrist, iii. 375
vertebral, injuries of, ii. 43
Arterio-aneurism of internal carotid, i. 232
Arteriorrhaphy, Matas', iii. 657
Arteriovenous aneurisms of axilla, iii. 82
of common carotid, ii. 73
of external carotid, ii. 75
of subclavian, ii. 75
Arthritis deformans, iii. 785
coxa vara in, iii. 518
of elbow-joint, iii. 212
of foot, treatment of, iii. 785
of hand, iii. 348
of hip-joint, iii. 494
of knee-joint, chronic, iii. 619
neuropathic, iii. 350
Arthropathy of Charcot of knee-joint, iii. 625
Articular ankylosis of jaw, i. 716
Articulations of jaw, diseases of, i. 715
of skull, rupture of, during labor, i. 24
temporomaxillary, diseases of, i. 715
Artificial distention in abdominal tumors, iv. 244
in examination of intestine, iv. 253
of stomach, iv. 235
Ascites, iv. 199
from echinococcus of liver, iv. 644
Aseptic catheter, v. 485
peritonitis, iv. 162
Asphyxia in phlegmonous glossitis, i. 836
Aspiration of bile from peritoneal cavity, iv. 638
in peritonitis, iv. 169
Astragalectomy for club-foot, iii. 822
Astragalus, dislocation of, total, iii. 762
excision of, iii. 885
fractures of, iii. 744
resection of, iii. 885
Atheroma of biliary passages, iv. 694
of face, i. 519
of gall-bladder, iv. 694
pendulous, i. 55
of thigh, iii. 557
Atresia ani, v. 83
et recti, v. 83
at boundary between mesopharynx and mouth, i. 903
of hypopharynx, i. 903
of œsophagus, iv. 23, 24
recti, v. 83
Atrophy, "smooth," of root of tongue, i. 826
Auditory canal, disposal of, after radical operation, i. 406
external, foreign bodies in, i. 351
hyperostosis of, i. 389
Körner's method of restoration after radical operation, i. 407
Passow's method of restoration after radical operation, i. 407
nerve, injuries of, i. 238
Auscultation in examination of intestines, iv. 235
of œsophagus, iv. 20
of stomach, iv. 235
Avicenna's method for forward dislocation of shoulder, iii. 68
Axilla, abscess of, iii. 80
adenitis of, iii. 80
aneurisms of, iii. 81
eczema of, iii. 80
hæmatoma of, iii. 22
inflammatory processes of, iii. 80
neoplasms of, iii. 83
tumors of, iii. 83
Axillary abscesses, iii. 80
adenitis, iii. 80
artery, injuries of, iii. 20
ligation of, iii. 105
dislocations of shoulder, iii. 61
eczema, iii. 80
furuncle, iii. 80
hydradenitis, iii. 80
nerves of shoulder, injuries of, iii. 23
vein, injuries of, iii. 23

BALANOPOSTHITIS, v. 637
Bardenheuer's extension for dislocated clavicle, iii. 39
for fractured clavicle, iii. 32
incision in lumbar nephrectomy, v. 398
for supracondyloid fracture of humerus, iii. 475

Bardenheuer's transverse incision for suprapubic section, v. 532
treatment of Pott's fracture, iii. 740
Barker's operation for radical cure of hernia, iv. 509
Bassini's operation for radical cure of hernia, iv. 511, 536
Baum's method for dislocated clavicle, iii. 37
Baynton's method for ulcers of legs, iii. 687
Bean's incision in lumbar nephrectomy, v. 396
Beck's coaptation splint, iii. 307
Beely's apparatus for hollow foot, iii. 850
plaster-of-Paris splint for leg, iii. 678
rowing apparatus for scoliosis, ii. 792
splint for club-foot, iii. 814
for fractured humerus, iii. 57
Bergmann's incision in lumbar nephrectomy, v. 397
Biceps, rupture of, iii. 119
tendon, dislocation of, iii. 119
ossification of, iii 242
Bile-ducts, injuries of, iv. 638
rupture of, iv. 637
Biliary fistula, iv. 692
passages, atheroma of, iv. 694
calculi of, iv. 665
carcinoma of, iv. 694
echinococcus of, iv. 694
fibroma of, iv. 694
inflammations of, iv. 663
myxoma of, iv. 694
papilloma of, iv. 694
sarcoma of, iv. 694
tumors of, iv. 694
Billroth's apparatus for loose shoulder, iii. 102
Bilocular hydrocele, v. 676
Bladder, adenoma of, v. 523
appearance of, in cystitis, v. 474
calculus of, v. 499
carcinoma of, v. 523
cystophotographs of, v. 528
catarrh of, v. 470
from tumor, v. 526
clefts of, v. 429
congenital abnormalities of, v. 428
cysts of, v. 524
diseases of, v. 464
double, v. 446
drainage of, in cystitis, v. 489
ectopia of, v. 428
eversion of, v. 428
examination of, v. 195, 419
fistulas of, traumatic, v. 456
forceps with electric lamp, v. 534
foreign bodies in, v. 459
hemorrhage of, from tumor, v. 525
hernia of, v. 464
operation for, v. 468
hypertrophy of, result of cystitis, v. 476, 482
inflammations of, v. 470
Bladder, injuries of, v. 447
associated with external injuries, v. 454
fistula following, v. 456
urinary fistula following, v. 456
irrigation of, technic of, v. 493
myoma of, v. 524
myxoma of, v. 524
papilloma of, benign, cystophotographs of, v. 528
prolapse of, v. 464
rectum used as, v. 442
rupture of, v. 447
sarcoma of, v. 524
syringe, v. 488
tuberculosis of kidney from, v. 332
tumors of, v. 521
cystitis due to, v. 499
involving ureter, v. 535
wounds of, perforating, v. 455
Blepharoplasty, i. 566
Dieffenbach's method, i. 557
Jordan's method, i. 559
median method, i. 557
Blood in carcinoma of stomach, iv. 376
-clots in ureter, v. 193
cysts of neck, ii. 126
Bloodvessels, spread of carcinoma of stomach through, iv. 375
Bodenhammer's rectocolonic speculum, v. 79
Boils of chest-wall, ii. 452
of neck, ii. 75
Bone filling, v. Mosetig's, iii. 702
tumors of ear, i. 389
Bones, carpal, fracture of, iii. 300
facial, injuries of, i. 472
of fingers, diseases of, iii. 346
of foot, inflammation of, iii. 781
tuberculosis of, iii. 785
of forearm, fracture of, iii. 246
upper end of, iii. 189
injuries of, iii. 247
malformations of, iii. 243
osteomyelitis of, iii. 255
tumors of, iii. 257
of hand, acromegaly of, iii. 351
diseases of, iii. 346
inflammation of, iii. 346
hyoid, fracture of, ii. 38
inflammations of, ii. 39
of leg, fracture of shaft of, iii. 671
syphilis of, iii. 705
tuberculosis of, iii. 703
tumors of, iii. 710
malar, fractures of, i. 473
maxillary, tuberculosis of, i. 676
of nose, fractures of, i. 475
of orbit, fractures of, i. 111
of pelvis, fractures of, v. 23
syphilis of, v. 55
tuberculosis of, v. 50
of skull, fractures of, i. 65
senile atrophy of, i. 132

Bones, suture of Hennequin and Wille, iii. 136
of tarsus, suppuration of, iii. 783
of thigh, diseases of, iii. 551
injuries of, iii. 535
of toes, acute inflammation of, iii. 783
Bottini's prostatic incisor, v. 557
Bougies, dilating, for rectum, v. 122
Bowlegs, iii. 645
Braatz' epaulette dressing, iii. 31
Brachial artery, aneurism of, iii. 145
injuries of, iii. 121
ligation of, iii. 156
neuritis, iii. 145
plexus, injuries of, ii. 64
Brain, abscess of, i. 275
compression of, i. 189
concussion of, i. 178
contusions of, i. 239
diseases of, i. 165
foreign bodies in, i. 268
hernia of, i. 273
injuries of, i. 165
and membranes, congenital diseases of, i. 165
diseases of, i. 165
injuries of, i. 165
rupture of, i. 243
tumors of central convolution, i. 321
vessels of, diseases of, i. 165
injuries of, i. 165
wounds of, i. 245
contused, i. 246
gunshot, i. 246
infected, i. 269
lacerated, i. 249
punctured, i. 248
Branchial cleft, malformation of pharynx due to, i. 877
outgrowths of skin of neck, ii. 23
second, fistula of, ii. 19
Branchiogenic abscesses of neck, ii. 123
cysts of neck, ii. 120
tumors of neck, ii. 123
Breast, actinomycosis of, ii. 575
adenoma of, ii. 580
angioma of, ii. 580
carcinoma of, ii. 586
chondroma of, ii. 581
cystadenoma of, ii. 571
cystic disease of, ii. 571
echinococcus of, ii. 575
fibro-adenoma of, ii. 578
hypertrophy of, ii. 576
inflammations of, specific, ii. 574
lipoma of, ii. 581
male, tumors of, ii. 610
myxoma of, ii. 580
neuralgia of, ii. 576
osteoma of, ii. 581
sarcoma of, ii. 581
sebaceous cysts of, ii. 581
syphilis of, ii. 575
tuberculosis of, ii. 574
tumors of, ii. 577
Broca's convolution, i. 255–259
Brodie's catheter for hypertrophy of prostate, v. 551
Bronchiectasis, ii. 515
Brown's ureter cystoscope, v. 202
Bruck's air cushion, iii. 694
Bruns' flexible canula, ii. 260
method for forward dislocation of shoulder, iii. 68
tibiocalcaneal resection, iii. 886
Bubo, indolent, of syphilis of inguinal gland, iii. 522
Bubonocele, iv. 555
Buccal mucous membrane, carcinoma of, i. 875
Burns of air-passages, ii. 162
of chest, ii. 372
of face, i. 469
of fingers, iii. 332
of hand, iii. 332
of larynx, ii. 162
of stomach, iv. 274
of tongue, i. 814
Bursa achillea, iii. 780
glutei medii, iii. 519
minimi, iii. 519
gluteotuberosa, iii. 520
iliac, ii. 519
iliaca posteriori, iii. 520
popliteal, hygroma of, iii. 652
semimembranosa, hygroma of, iii. 652
serous inflammation of, iii. 652
subcutanea femoris, iii. 520
subiliaca, iii. 519
tendinis atheratoris interni, iii. 519
trochanteric, iii. 519
vaginalis obturatoris interni, iii. 519
Bursæ of fingers, diseases of, iii. 346
of foot, diseases of, iii. 780
of hand, diseases of, iii. 346
of hip, inflammation of, iii. 519
of knee, diseases of, iii. 649
of shoulder, diseases of, iii. 78
Bursitis, acromial, iii. 78
infraungual, iii. 651
olecranon, iii. 144
prepatellar, iii. 650
pretibialis, iii. 651
semimembranosa, iii. 652
semitendinosa, iii. 652
subdeltoid, iii. 78
subiliac, iii. 521
trochanteric, iii. 521
Butterfly fracture, iii. 139

CACHEXIA in carcinoma of stomach, iv. 376
Calcaneum, dislocation of, iii. 765
excision of, iii. 884
fractures of, iii. 746
resection of, iii. 884
Calcium oxalate, vesical calculi composed of, v. 503
Calculi, biliary, iv. 665

Calculi of nose, i. 755
prostatic, v. 557
salivary, i. 618
of seminal vesicles, v. 719
of ureter, impacted, v. 387
in urethra, v. 619
vesical, v. 499
cystophotographs of, v. 510
facetted, v. 505
Calculus of bladder, v. 499
of kidney, v. 293
of pancreas, iv. 726, 739
Capitulum of humerus, fracture of, iii. 188
Capsule, internal, injuries of, i. 260
Caput obstipum, ii. 26
succedaneum, i. 18
Carbolic gangrene of fingers, iii. 341
of hand, iii. 341
Carbuncles of chest-wall, ii. 452
of face, i. 479
of neck, ii. 75
Carcinoma and adenoma of sebaceous glands, relation of, i. 61
of biliary passages, iv. 694
of bladder, v. 524
cystophotographs of, v. 528
of buccal mucous membrane, i. 875
of chest-wall, ii. 471
of Cowper's glands, v. 623
of ear, i. 392
of face, i. 522
of femur, iii. 557
of foot, iii. 872
of gall-bladder, iv. 694
of gums, i. 695
of hand, iii. 367, 373
of humerus, iii. 154
intestinal obstruction from, iv. 344
of intestine, iv. 390
of jaw, i. 707
of kidney, v. 355
of larynx, ii. 236
of lids, i. 529
of lips, i. 522
of liver, iv. 655
of lungs, ii. 525
of male breast, ii. 610
of mammary gland, ii. 585
of mouth, i. 862
of nasopharynx, i. 797
of neck, primary, ii. 138
of œsophagus, iv. 111
of pancreas, iv. 737
of penis, v. 645
of peritoneum, iv. 196
of pharynx, i. 912
of prostate gland, v. 563
of rectum, v. 148
of salivary glands, i. 651
of scalp, i. 60
of scrotum, v. 666
of stomach, iv. 370
of testicle, v. 715
of thyroid gland, ii. 547
Carcinoma of tongue, i. 862
of umbilicus, iv. 149
of urethra, v. 622
Carotid arteries, arterial aneurism of, ii. 66–70
arteriovenous aneurism of, ii. 73, 75
cerebral, injuries of, i. 231
common, ligation of, preliminary, in resection of jaw, i. 726
erosion of, from drainage-tube in pharynx, i. 917
external, ligation of, in scalp-wounds, i. 35
preliminary, in resection of jaw, i. 727
injuries of, ii. 44
ligation of, ii. 44
Carpal bones, fracture of, iii. 300
Carpus, resection of, iii. 380
Cartilaginous tumors of ears, i. 388
Caspar's ureter cystoscope, v. 201
Castration, v. 717
for hypertrophy of prostate, v. 559
Catarrh of bladder, v. 470
from tumor, v. 526
of stomach, iv. 59
Cathelin's urine segregator, v. 209
Catheter, aseptic, v. 485
cystoscopic evacuation, v. 519
for hypertrophy of prostate, v. 551
retention, v. 595
Catheterization, ureteral, v. 195
Caudal growths in man, v. 19
Caustics, injuries of tongue caused by, i. 815
Cavernitis, v. 641
Cavernoma of hand, iii. 367
Cavernous lymphangioma of tongue, i. 845
tumors associated with myeloceles, v. 20
Cellulitis, diffuse, complicating lacerated wounds of the scalp, i. 32
of neck, ii. 85
of face, i. 479
of fingers, iii. 322
of foot, iii. 773
of hand, iii. 322
of leg, iii. 684
of penis, v. 640
of stomach, iv. 315
Cephalhæmatoma in newborn, i. 19
Cephalocele, i. 165
Cephalohydrocele traumatica, i. 83
Cerebellar ataxia, i. 262
Cerebral abscess, i. 275
compression, i. 189
disturbances accompanying osteomyelitis of cranial bones, i. 163
hemorrhage, aphasia in, i. 215
localization, i. 252
Cervical rib, ii. 24
sympathetic nerve, injuries of, ii. 64

Championnière's operation for radical cure of hernia, iv. 507
Chancre of face, i. 495
of lips, i. 495
Chancroid of rectum, v. 101
Charcot's knee-joint, iii. 625
Chassaignac-Bruns' method of reflecting nose, i. 804
Chassaignac's method of ligation of vertebral artery, ii. 52
Chassepot projectile, i. 118
Cheek, plastic operation on, i. 552
Cheiloplasty, i. 543
Dieffenbach's method, i. 545
Langenbeck's method, i. 549
Chest, burns of, ii. 372
concussion of, ii. 371
contusions of, ii. 367
injuries of, non-perforating, ii. 372
malformations of, acquired, ii. 451
-walls, abscesses of, ii. 454
boils of, ii. 452
carbuncles of, ii. 452
carcinoma of, ii. 471
cavernous hæmangioma of, ii. 465
dermoids of, ii. 461
diseases of, ii. 452
echinococcus of, ii. 471
enchondroma of, ii. 466
ephelides of, ii. 461
fibroma of, ii. 464
keloids of, ii. 461
lipoma of, ii. 462
lymphangioma of, ii. 465
nævi of, ii. 461
neuromata of, ii. 465
sarcoma of, ii. 469
sebaceous cysts of, ii. 461
telangiectases of, ii. 465
tumors of, ii. 461, 469
wounds of, simple penetrating, ii. 378
Chin, initial lesion on, i. 495
Choked disk in cerebral compression, i. 216
in sinus thrombosis, i. 297
Cholecystectomy, iv. 684
Cholecystenterostomy, iv. 686
Cholecystostomy, iv. 681
Choledochotomy, iv. 693
Cholelithiasis, iv. 665
Cholesteatoma, i. 382, 390
of mammary gland, ii. 581
Chondrodystrophia, i. 129
Chondrofibroma, cystic, of femur, iii. 555
Chondroma of femur, iii. 556
of foot, iii. 870
of jaw, i. 701
of mammary gland, ii. 581
Chopart's amputation at mediotarsal joint, iii. 877
joint, iii. 717
dislocation in, iii. 765
Chylothorax, ii. 487
Circumcision, v. 630
Cirsoid aneurism of hand, iii. 368
Clamp, varicocele, v. 690
Clavicle, congenital defect of, iii. 17
diseases of, iii. 85
dislocation of, iii. 34
acromial end of, iii. 35
downward, iii. 37
upward, iii. 35
sternal end of, iii. 38
backward, iii. 40
forward, iii. 39
upward, iii. 39
total, iii. 41
excision of, iii. 110
fracture of, iii. 26
lymph-glands above, enlarged in carcinoma of stomach, iv. 375
neoplasms of, iii. 85
resection of, iii. 110
syphilis of, iii. 85
tuberculosis of, iii. 85
tumors of, iii. 85
Clavus, iii. 774
Cleft of bladder, v. 429
facial, oblique, i. 421
transverse, i. 423
formation, i. 411–423
median, of lower lip and under jaw, i. 424
of nose, i. 419
palate, i. 443
of upper lip, i. 414
Club-foot, iii. 800
Club-hand, congenital, iii. 278
Coccygodynia, v. 43
Coccyx, tumors of, v. 20
Coin-catcher, Graefe's, iv. 45
Colic, renal, v. 346
Colles' fracture, iii. 28
Colloid goitre, ii. 316
Colon, relation of, to kidney, v. 180
Colonic irrigation, iv. 237
Colopexy, v. 142
Colostomy, iv. 456
Compression of brain, i. 189
Compressor, orchitis, v. 699
varicocele, v. 690
Concretion of umbilicus, iv. 146
Concussion of brain, i. 178
of chest, ii. 371
of larynx, ii. 149
Congenital abnormalities of bladder, v. 428
of kidney, v. 218
of ureter, v. 221
anomalies of intestine, iv. 249
of penis, v. 625
of scrotum, v. 653
of stomach, iv. 249
atresia of œsophagus, iv. 23, 24
club-hand, iii. 278
coxa vara, iii. 518
cysts of pharynx, i. 877
defects of clavicle, iii. 17

Congenital defects of leg, iii. 669
dermoids of pharynx, i. 905
diseases of brain and membranes, i. 165
of mouth, i. 807
of tongue, i. 807
dislocation of hip, iii. 389
of radius, iii. 164
of shoulder, iii. 18
elephantiasis of face, i. 505
elevation of scapula, iii. 17
fissure of sternum, ii. 447
fistula, i. 441
of lower lip, i. 440
of rectum, v. 86
fractures of skull, i. 23
hernia, iv. 591
of cord, iv. 593
inguinal, iv. 560
hydrocele, v. 676
hydrocephalus, i. 173
hypertrophy of arm, iii. 117
of foot, iii. 722
of hand, iii. 270
internal diverticulum, iv. 493
macroglossia, i. 805
malformations of anus, v. 83
of bones of forearm, iii. 163
of ear, i. 347
of elbow-joint, iii. 163
of face, i. 411
of foot, iii. 722
of forearm, iii. 163
of hand, iii. 270
of hip, iii. 389
of larynx, ii. 145
of leg, iii. 669
of mammary glands, ii. 562
of mouth, i. 807
of nasopharynx, i. 743
of nose, i. 743
of œsophagus, iv. 23
of pelvis, v. 17
of pharynx, i. 877
of rectum, v. 83
of ribs, ii. 449
of sternum, ii. 446
of thorax, ii. 446
of tongue, i. 807
of trachea, ii. 147
of ulna, iii. 243
of umbilicus, iv. 142
of upper arm, iii. 117
of urachus, iv. 145
of urethra, v. 569
of vertebral column, ii. 652
phimosis, v. 626
rhachitis, i. 130
scoliosis, ii. 775
serous cysts of neck, ii. 123
stenosis of intestine, iv. 251
strictures of œsophagus, iv. 25
of urethra, v. 571
tumors of sacrum, v. 17
Constriction of liver, iv. 658
Constriction of penis, v. 632
of urethra, v. 570
Contracted foot, iii. 850
Contractions, cicatricial, of fingers, iii. 319
of hand, iii. 319
Contracture at elbow, iii. 231
of fingers, iii. 356
of foot, iii. 795
of hand, iii. 356
of hip-joint, iii. 502
of knee-joint, iii. 626
of shoulder-joint, iii. 98
of toes, iii. 851
Contusions of abdominal wall, iv. 124
of brain, i. 239
of chest, ii. 367
of elbow-joint, iii. 166
of epididymis, v. 693
of face, i. 459
fracture, ii. 672
of knee, iii. 565
of larynx, ii. 149
of shoulder-joint, iii. 44
of spleen, iv. 200
of testicle, v. 693
of vertebræ, ii. 672
of wrist, iii. 279
Cooper's hernia knife, iv. 527
method for forward dislocation of shoulder, iii. 68
Cord, spermatic, diseases of, v. 668
fibroma of, v. 687
hæmatocele of, chronic, v. 685
hæmatoma of, v. 668
hydrocele of, v. 672
bilocular, v. 676
chronic, v. 673
congenital, v. 676
diffuse, v. 686
multilocular, v. 686
lipoma of, v. 687
membranes of, acute inflammations of, v. 670
chronic inflammations of, v. 673
injuries of, v. 668
tumors of, v. 687
sarcoma of, v. 687
spinal, compression-caries of, ii. 632
destruction of, ii. 628
diseases of, ii. 611
hæmatomyelia of, ii. 630
injuries of, treatment of, ii. 638
membranes of, diseases of, ii. 625
injuries of, ii. 625
Corns, iii. 774
Cornua cutanea, i. 521
Corpora cavernosa, lacerations of, v. 632
quadrigemina, injuries of, i. 261
Corpus striatum, injuries of, i. 261
Cortex of kidney, tumors of, v. 364
Costal cartilages, dislocation of, ii. 444
fracture of, ii. 441

Cowper's glands, carcinoma of, v. 623
diseases of, v. 624
fistula of, v. 624
inflammation of, v. 624
suppuration of, v. 624
Coxa vara, iii. 511
adolescentium, iii. 513
in arthritis deformans, iii. 518
congenital, iii. 518
Kocher's, iii. 513
in osteomalacia, iii. 518
rhachitic, iii. 518
traumatic, iii. 519
Coxitis in acute osteomyelitis, iii. 458
by direct infection, iii. 456
following infectious diseases, iii. 453
gonorrhœal, iii. 454
in infancy, iii. 455
rheumatic, iii. 455
syphilitic, iii. 455
traumatic, iii. 453
tuberculosa, iii. 463
typhoid, iii. 455
Cranial bones, depressions of, during labor, i. 22
echinococcus of, i. 141
injuries of, i. 233
leontiasis of, i. 139
osteomyelitis of, acute, i. 161
solution of continuity of, during labor, i. 23
syphilis of, i. 150
tuberculosis of, i. 158
tumors of, i. 134
nerve, neuralgia of. *See* Neuralgia.
paralysis of, in fracture of skull, i. 91
Craniocerebral topography, i. 333
Craniotabes, i. 127
Creaking scapula, iii. 80
Credé's rectal bougie, v. 121
Cretinism, ii. 351
Cretins, thyroid gland of, ii. 354
Cricoid cartilage, ligation of common carotid at level of, ii. 44
Croupous diphtheria, ii. 175
Crushes of pelvis, v. 38
Cryoscopy, v. 213
Cryptorchismus, iv. 564
Cubital adenitis, iii. 143
artery, ligation of, iii. 227
Cubitus valgus, normal, iii. 164
Curvatures of leg, rhachitic, iii. 706
of spine, ii. 767
kyphotic, ii. 769
lateral, ii. 775
scoliotic, ii. 775
lordotic, ii. 773
of thigh, iii. 530
Cystadenoma of breast, ii. 571
Cystendysis, iv. 685
Cystic bursæ of thyroid region, ii. 128
dilatation of ureters, v. 227
disease of breast, ii. 571
goitre, ii. 318
Cystic lymphangioma associated with myeloceles, v. 20
teratoma of kidney, v. 372
tumors of kidney, v. 366
of liver, iv. 643
of neck, ii. 120
of pharynx, i. 908
Cysticerci of face, i. 521
Cystin, vesical calculi composed of, v. 503
Cystitis, v. 470
appearance of bladder in, v. 474
chronic, treatment of, v. 492
diphtheritic, v. 476
drainage of bladder in, v. 489
due to calculus of bladder, v. 498
hypertrophy of prostate, v. 497
stricture, v. 497
tumors of bladder, v. 499
following gonorrhœa, v. 495
pericystitis, v. 483
hypertrophy of bladder, result of, v. 476, 482
interstitial, v. 482
membranous, v. 476
traumatic, v. 471
tuberculous, v. 495
urinary sediment in, v. 480
urine in, v. 477
Cystocele, vaginal, v. 469
Cystoma of jaw, i. 609
multilocular, v. 710
Cystophotographs of benign papilloma of bladder, v. 528
of carcinoma of bladder, v. 528
of vesical calculi, v. 510
Cystosarcoma phyllodes, ii. 578
proliferation of mammary gland, ii. 578
Cystoscope, Albarran's, v. 201
Brown's, v. 202
Caspar's, v. 201
in examination of bladder, v. 424
for calculi of kidney, v. 508
of suppurative nephritis, v. 289
for tuberculosis of kidney, v. 326
Nitze's operating, v. 531
tumors of bladder removed through, v. 530
urethral, v. 203
Cystoscopic evacuation catheter, v. 519
Cystotomy, suprapubic, in treatment of hypertrophy of prostate, v. 555
Cysts of bladder, v. 524
of chest-wall, sebaceous, ii. 461
dental follicular, i. 698
of foot, epithelial, iii. 871
of hand, sebaceous, iii. 309, 369
of hydatid of Morgagni, v. 707
of kidney, echinococcus, v. 366
paranephritic, v. 372
simple, v. 367
solitary, v. 371
of liver, iv. 653
hydatid, iv. 643

Cysts of mammary gland, sebaceous, ii. 581
of mucous glands of mouth, i. 847
of neck, blood-, ii. 126
branchiogenic, ii. 120
congenital serous, ii. 123
echinococcus, ii. 129
sebaceous, ii. 128
subcutaneous dermoid, ii. 126
of œsophagus, iv. 106
of pancreas, iv. 726
of penis, v. 643
periosteal, i. 699
of pharynx, congenital, i. 877
popliteal, iii. 652
of prostate, v. 564
of salivary ducts, i. 639
glands, i. 641
of scrotum, v. 666
of spleen, iv. 704, 706
of testicle, v. 707
dermoid, v. 716
of thigh, dermoid, iii. 557
of umbilicus, sebaceous, iv. 149
of ureter, v. 391
of vitello-intestinal duct, iv. 144
Czerny's method of suture of intestine, iv. 398
operation for radical cure of hernia, iv. 507

DACTYLITIS syphilitica, iii. 786
Dactylolysis, spontaneous, of toes, iii. 774
D'Antona's incision in lumbar nephrectomy, v. 397
Decortization of lung in pleural effusion, ii. 499
Decubital ulcers of œsophagus, iv. 63
Defects of skull in newborn, i. 25
Deflection of nasal septum, i. 751
Deformities of foot, iii. 795
of hand, iii. 356
of hip, paralytic, iii. 510
of knee-joint, paralytic, iii. 633
static, iii. 634
of skull in newborn, i. 21
of thigh, iii. 530
of toes, iii. 851
Degeneration, polycystic, of kidney, v. 367
Deltoid paralysis following dislocation of shoulder, iii. 70
rupture of, iii. 19
Dental cysts, follicular, i. 696
Depressions of cranial bones during labor, i. 22
Dermatogenic contractures, ii. 37
Dermoid cysts of chest-wall, ii. 461
of ear, i. 390
of face, i. 519
of lung, ii. 529
of nasopharynx, i. 795
of neck, subcutaneous, ii. 126
of pharynx, congenital, i. 877
of scalp, i. 58
Dermoid cysts of scrotum, v. 666
of testicle, v. 716
of thigh, iii. 557
of tongue, i. 852
of umbilicus, iv. 149
Deviations of cartilaginous septum, i. 752
of nasal septum, i. 751
Diabetic gangrene of fingers, iii. 339
of hand, iii. 339
Diacondyloid fracture of humerus, iii. 187
Diaphragm, injuries of, ii. 418
surgical diseases of, ii. 555
Diaphragmatic hernia, iv. 624
Dieffenbach's method of cheiloplasty, i. 545
Diffuse hydrocele of spermatic cord, v. 686
peritonitis, iv. 161
Digits, supernumerary, iii. 272
Dilatation, gastric, acute, iv. 294
of intestine, from stenosis, iv. 296
suppurative, of kidney, v. 283
of urethra, v. 570
Dilating bougies for rectum, v. 122
Dilator, prepuce, v. 629
and urethrometer, v. 604
Diphtheria, croupous, ii. 175
of œsophagus, iv. 59
of pharynx, i. 886
Diphtheritic cystitis, v. 476
Diplococcus pneumoniæ in fracture of base of skull, i. 105
Direct inguinal hernia, iv. 569
Disarticulation of jaw, i. 720
Dislocations of astragalus, total, iii. 762
of biceps tendon, iii. 19
of calcaneum, iii. 765
in Chopart's joint, iii. 765
of clavicle, iii. 34
acromial end of, iii. 35
downward, iii. 37
upward, iii. 35
sternal end of, iii. 38
backward, iii. 40
forward, iii. 39
upward, iii. 39
total, iii. 41
of costal cartilages, ii. 444
of elbow-joint, iii. 198
backward, iii. 199
diverging, iii. 206
forward, iii. 206
lateral, iii. 204
of fibula, iii. 681
of foot, iii. 751
lateral, iii. 752
inward, iii. 754
outward, iii. 752
sagittal, iii. 755
backward, iii. 755
forward, iii. 756
upward, iii. 757
of hip, iii. 416
backward, iii. 417
bilateral, iii. 432
centrally, iii. 431

Dislocations of hip, congenital, iii. 389
downward, iii. 429
forward, iii. 424
iliac, iii. 417
infrapubic, iii. 426
paralytic, iii. 510
sciatic, iii. 418
suprapubic, iii. 424
upward, iii. 430
voluntary, iii. 432
isolated, of lateral joints of vertebræ, ii. 666
of knee, iii. 583
backward, iii. 583
forward, iii. 583
menisci of, iii. 591
sideways, iii. 584
of laryngeal cartilages, ii. 149
of lower jaw, i. 670
in mediotarsal joint, iii. 765
of metacarpals, iii. 309
of metatarsals, iii. 769
of metatarsus, total, iii. 769
of patella, iii. 588
congenital, iii. 589
downward, iii. 591
lateral, iii. 588
vertical, iii. 590
of pelvis, v. 38
of penis, v. 634
of phalanges of fingers, iii. 309
of foot, iii. 769
of thumb, iii. 311
of toes, iii. 760
of radius, congenital, iii. 164
at elbow, iii. 207
head of, iii. 207
lower end of, iii. 303
of ribs, ii. 444
of sacrum, with involvement of both sacro-iliac joints, v. 38
of shoulder, iii. 60
backward, iii. 71
infraspinate, iii. 71
subacromial, iii. 72
congenital, iii. 18
deltoid paralysis following, iii. 70
forward, iii. 61
axillary, iii. 61
subcoracoid, iii. 61
habitual, iii. 76
old, iii. 73
of small tarsals, iii. 766
subastragaloid, iii. 758
of tarsal bones, iii. 758
of tendons of foot, iii. 729
of hand, iii. 280
of testicle, v. 693
of testicle, v. 693
of thumb, iii. 311
of ulna at elbow, iii. 207
lower end of, iii. 303
of wrist, iii. 301
unilateral, of lateral joints of vertebræ, ii. 667
Displacement of intestine, iv. 252
of liver, iv. 657
Dissector's tuberculous axillary adenitis, iii. 81
Diverticula, acquired of intestine, iv. 252
Diverticulum, congenital internal, iv. 493
deep-seated, of œsophagus, iv. 102
false, iv. 493
Meckel's, iv. 493
of œsophagus, iv. 94
of pharynx, i. 877
of vitello-intestinal duct, iv. 144
Dorsal œsophagotomy, iv. 52
Double bladder, v. 446
ureter, v. 225
Doyer's method of ligation of intestine, iv. 402
Drainage of ventricles, i. 205
Drum-membrane, injuries of, i. 354
rupture of, diagnosis of, i. 357
Duct, parotid. *See* Parotid duct.
Steno's, injuries of, i. 609
thyroglossal, i. 910
Ductus thyroglossus, fistulæ of, ii. 21
Dumb-bell pessary, v. 131
Duodenal ulcer, peritonitis from, iv. 179
Duodenostomy, iv. 455
Duodenum, injuries of, iv. 299
ulcer of, iv. 315
Duplay's operation for epispadias, v. 577
Dupuis' canula, ii. 281
Dupuytren's contracture of fingers, iii. 362
splint for Pott's fracture, iii. 739
Dura mater, sarcoma of, i. 146
Dynamic ileus, iv. 331

EAR, actinomycosis of, i. 386
adenoma of, i. 390
angioma of, i. 388
carcinoma of, i. 392
cysts of, dermoid, i. 390
sebaceous, i. 390
ecchondrosis ossificans of, i. 389
endothelioma of, i. 392
examination of, methods of, i. 340
exostosis cartilagenia of, i. 389
eburnea of, i. 389
spongiosa of, i. 389
external, burns of, i. 349
frostbites of, i. 349
inflammations of, i. 361
injuries of, caused by caustic, i. 349
fibroma of, i. 387
flow of serous fluid from, in fracture of skull, i. 90
granuloma of, i. 386
hemorrhage from, source of, in fracture of skull, i. 88
inflammations of, i. 361
injuries of, i. 347
gunshot, i. 359
keloid of, i. 387

Ear, malformations of, i. 347
middle, chronic suppuration of, i. 380
sarcoma of, i. 393
syphilis of, i. 386
tuberculosis of, i. 384
tumors of, i. 386
bone, i. 389
cartilaginous, i. 388
warts of, i. 390
Ecchondrosis ossificans of ear, i. 389
Echinococcus of abdominal wall, iv. 137
of biliary passages, iv. 694
of chest-wall, ii. 471
of cranial bones, i. 141
of face, i. 521
of femur, iii. 557
of gall-bladder, iv. 694
of humerus, iii. 151
of kidney, v. 366
of liver, iv. 643
of lung, ii. 521
of mammary gland, ii. 575
of neck, ii. 129
of pelvis, v. 71
of pleura, ii. 500
of spine, ii. 761
of spleen, iv. 705
of thyroid gland, ii. 346
Ectasis of œsophagus, iv. 92
Ectopia of bladder, complete, v. 428
incomplete, v. 428
viscerium, iv. 593
Eczema of axilla, iii. 80
of leg, iii. 684
Elbow, contracture at, iii. 231, 241
infusion at, iii. 235
-joint, amputations at, iii. 226
arteries at, ligation of, iii. 227
arthritis deformans of, iii. 212
contusions of, iii. 166
diseases of, iii. 210
dislocations of, iii. 198
backward, iii. 199
diverging, iii. 206
forward, iii. 206
lateral, iii. 201
of radius at, iii. 207
of ulna at, iii. 207
fracture of, iii. 167
free bodies in, iii. 213
gout of, iii. 212
inflammation of, iii. 210, 212
injuries of, iii. 166
loose, iii. 225
malformations of, iii. 163
mechanism of, iii. 161
nerves at, location of, iii. 227
operations on, iii. 222
resection of, iii. 222
sprains of, iii. 166
suppuration of, iii. 211
syphilis of, iii. 211
tuberculosis of, iii. 215
wounds of, gunshot, iii. 197
median nerve at, injuries of, iii. 237
Elbow, nerves at, diseases of, iii. 236
injuries of, iii. 236
operations on, iii. 259
radial nerve at, injuries of, iii. 236
skin of, contraction of, iii. 231
diseases of, iii. 229
injuries of, iii. 229
soft parts of, injuries of, iii. 229
synovial sacs at, diseases of, iii. 233
injuries of, iii. 233
tendons of, diseases of, iii. 233
injuries of, iii. 233
ulnar nerve at, injuries of, iii. 238
vessels of, diseases of, iii. 234
injuries of, iii. 234
wing-skin at, iii. 229
Electric illumination of stomach, iv. 238
Electrolysis for stricture of urethra, v. 610
Elephantiasis of abdominal wall, iv. 141
of face, congenital, i. 505
of leg, iii. 695
nervorum (Bruns) of thigh, iii. 558
of nose, i. 505
of penis, v. 642
of scalp, case of, i. 44
of scrotum, v. 663
Elimination of intestine, iv. 478
of pylorus, iv. 453
Embolism from carcinoma of stomach, iv. 376
of mesentery, iv. 328
Embryonic adenosarcoma of kidney, v. 360
Emphysema in fissure of accessory sinus, i. 748
of mastoid in fracture of skull, i. 91
of mediastinum, ii. 540
of soft parts of skull, i. 40
Empyema of accessory sinuses of nose, i. 765
of antrum of Highmore, i. 480
of appendix, iv. 352
of ethmoid labyrinth, i. 771
of frontal sinus, i. 768
of maxillary sinus, i. 765
necessitatis of chest-wall, ii. 454
Encephalitis, traumatic purulent, i. 250
Enchondroma of chest-wall, ii. 466
of femur, iii. 555
of hand, iii. 370
of humerus, iii. 150
of lung, ii. 528
of neck, ii. 137
of nose, i. 784
of testicle, v. 714
End-to-end anastomosis, iv. 470
End-to-side anastomosis, iv. 472
Endoscope, urethral, v. 565
Endoscopic tube, v. 200
Endothelioma of ear, i. 392
of foot, iii. 871
of kidney, v. 358
of lung, ii. 529
of nasopharynx, i. 796

Endothelioma of tongue, i. 858
Enlargement of liver, iv. 658
Entero-anastomosis for carcinoma of intestine, iv. 396
Enteropexy, iv. 454
Enteroplasty, iv. 454
Enterorrhaphy, iv. 454
Enterostomy, iv. 454
for intestinal obstruction, iv. 346
Enteroteratoma, iv. 143
Enterotomy, iv. 454
for obstruction of intestine, iv. 346
Enterotribe, Mikulicz's, iv. 402
Enucleation in treatment of goitre, ii. 329
Ephelides of chest-wall, ii. 461
Epicystotomy, v. 228
Epididymis, contusions of, v. 693
diseases of, v. 693
inflammation of, acute, v. 694
injuries of, v. 693
tuberculosis of, v. 699
Epididymitis, acute, v. 694
chronic, v. 696
Epilepsy, changes in cerebral cortex, i. 308
cortical, i. 309
following fracture of skull, i. 98
injuries of head, i. 305
Epiphysis of humerus, lower, separation of, iii. 187
Epispadias, v. 574
Epithelial cysts in foot, iii. 871
tumors, benign, of nasopharynx, i. 795
of salivary gland, i. 650
Epithelioma of abdominal wall, iv. 137
of face, i. 522
polymorphous, i. 61
of scalp, i. 62
of umbilicus, iv. 149
Epulis, i. 694
carcinomatous, i. 695
Erysipelas of arm, iii. 143
complicating scalp-wounds, i. 33
of face, i. 482
following lupus, i. 486
of fingers, iii. 330
of hand, iii. 330
of leg, iii. 684
of neck, ii. 76
of penis, v. 641
of scalp, i. 62
of scrotum, v. 662
Ethmoid labyrinth, suppuration of, i. 771
Ethmoidal cells, probing of, i. 740
Evacuation catheter, cystoscopic, v. 519
pump for use in lithotrity, v. 518
Eversion of bladder, v. 428
Evulsion of upper arm, iii. 141
Exarticulation of hand, iii. 377
at knee, iii. 713
Excentric hypertrophy of prostate, v. 548
Excision of astragalus, iii. 885
of calcaneum, iii. 884
of clavicle, iii. 110
of seminal vesicles, v. 720
Excision of stomach, iv. 444
Exenteratio cranii, i. 247
Exercise-bone, iii. 84
Exophthalmos in fracture of skull, i. 87
pulsans, i. 232
Exostosis cartilaginea of ear, i. 389
eburnea of ear, i. 389
in foot, iii. 870
of humerus, iii. 150
of orbit, i. 134
spongiosa of ear, i. 389
Exothropexy in treatment of goitre, ii. 339
Exploratory puncture in operations for pleural effusions, ii. 488
Exposure of nose, preliminary operation for, i. 802
Extension treatment of supracondyloid fractures, iii. 176
External auditory meatus, hemorrhage from, in fracture of base, i. 88
Extirpation of stomach, iv. 444, 451
Exudative peritonitis, chronic, iv. 190
Eyeball, removal of, i. 730

FACE, actinomycosis of, i. 491
aneurism of, i. 515
angioma of, i. 511
anthrax of, i. 498
atheroma of, i. 519
burns of, i. 469
carcinoma of, i. 522
cellulitis of, i. 479
cleft formations of, i. 411
contusions of, i. 459
cutaneous horns of, i. 521
cysts of, i. 521
dermoids of, i. 519
erysipelas of, i. 482
fibroma of, i. 502
lipoma of, i. 501
lupus of, i. 485
lymphangioma of, i. 507
malformations of, i. 411
phlegmon of, i. 480
sarcoma of, i. 515
soft parts of, acute inflammation of, i. 479
injuries of, i. 459
syphilis of, i. 495
tuberculosis cutis of, i. 484
tuberculous adenitis of, i. 490
inflammations of, i. 485
ulcers of, i. 484
tumors of, i. 501
wounds of, i. 460
gunshot, i. 464
incised, i. 461
punctured, i. 463
Facetted vesical calculi, v. 505
Facial bones, acute suppurative otitis of, i. 481
periostitis of, i. 481
injuries of, i. 472
tuberculosis of, i. 490

Facial cleft, oblique, i. 421
transverse, i. 423
nerve, injuries of, i. 237
palsy of, caused by pressure during labor, i. 18
paralysis of, in fracture of skull, i. 91
False diverticulum, iv. 493
Fatty hernia, iv. 495
overgrowths of abdominal wall, iv. 141
Fecal fistula, iv. 284
impaction in intestinal obstruction, iv. 339
tumors of intestine, iv. 281
vomiting in intestinal obstruction, iv. 336
Feces, impaction of, within loop of intestine included in hernia, iv. 518
Felon, iii. 322
Femoral artery, aneurism of, iii. 549
injuries of, iii. 532
ligation of, iii. 559
hernia, iv. 576
vein, injuries of, iii. 532
Femur, carcinoma of, iii. 557
chondrofibroma of, iii. 555
chondroma of, iii. 556
diseases of, iii. 551
echinococcus of, iii. 557
enchondroma of, iii. 555
fibroma of, iii. 556
fracture of, condyles of, iii. 571
epiphyseal lines of, iii. 449
great trochanter of, iii. 448
gunshot, iii. 546
head of, iii. 434
neck of, iii. 435
shaft of, iii. 535
upper end of, iii. 433
lipoma of, iii. 556
myxoma of, iii. 556
osteomyelitis of, acute, iii. 551
sarcoma of, iii. 556
shaft of, gunshot-wounds of, iii. 546
tumors of, iii. 555
Fenestrated splint for leg, iii. 679
Fessenden-Otis urethrotome, v. 611
Fetal clefts, i. 440
Fever, urethral, v. 568
Fibro-adenoma of mammary gland, ii. 578
Fibroma of abdominal wall, iv. 133
of biliary passages, iv. 694
of chest-wall, ii. 464
of ear, i. 387
of face, i. 502
molluscum, i. 504
of femur, iii. 556
of gall-bladder, iv. 694
of gums, i. 694
of hand, iii. 369
of jaw, i. 700
of kidney, v. 353
of lung, ii. 528
Fibroma of nasopharynx, i. 788
of neck, ii. 132
of œsophagus, iv. 106
of prostate gland, v. 562
of salivary glands, i. 644
of scalp, i. 43
of spermatic cord, v. 687
of testicle, v. 687
of tongue, i. 857
of tunica vaginalis, v. 687
of umbilicus, papillary, iv. 148
Fibromatosis, i. 502
Fibula, dislocation of, iii. 681
fractures of, iii. 680
tuberculosis of, iii. 703
Fingers, acute inflammatory processes of, iii. 321
amputation of, iii. 378
bones of, diseases of, iii. 346
burns of, iii. 332
bursæ of, diseases of, iii. 342
cellulitis of, iii. 322
cicatricial contractions of, iii. 319
contractures of, iii. 356
erysipelas of, iii. 330
frost-bites of, iii. 332
furuncle of, iii. 329
gangrene of, iii. 338
glossy, iii. 317
joints of, diseases of, iii. 346
leprosy in, local effects of, iii. 337
lymphangitis of, iii. 331
operations on, iii. 374
panaritium of, articular, iii. 324
cutaneous, iii. 322
osseous, iii. 324
parungual, iii. 323
subungual, iii. 322
phalanges of, dislocations of, iii. 309
functions of, iii. 308
resection of, iii. 384
phlebitis of, iii. 331
post-traumatic neuritis of, iii. 318
periostitis of, iii. 320
pseudoerysipelas of, iii. 330
skin of, tuberculosis of, iii. 333
snapping, iii. 363
soft parts of, infection of, iii. 329
inflammation of, chronic, iii. 333
spina ventosa of, iii. 353
syphilis of, primary effects of, iii. 329
syphilitic affections of, iii. 336
syringomyelia in, local effects of, iii. 337
tendon-sheaths of, diseases of, iii. 342
tenosynovitis of, iii. 343
traumatic changes in joints of, iii. 319
trigger, iii. 363
trophic disturbances of, iii. 337
tuberculosis of, iii. 354
wounds of, iii. 314

Fink and Huesner's adhesive mixture, iii. 817
Fissura vesicæ, v. 428
Fissure of anus, v. 104
Fistula in ano, v. 111
to appendix, iv. 354
of bladder, traumatic, v. 456
complete occlusion of rectum without, v. 87
congenital, of rectum, v. 86
of Cowper's glands, v. 624
of ductus thyroglossus, ii. 21
fecal, iv. 284
gastric, iv. 281
gastro-intestinal, iv. 283
from hydatid cyst of liver, iv. 647
inflammatory, of umbilicus, iv. 146
intestinal, closure of, iv. 463
external, iv. 283
internal, iv. 287
between intestine and bladder, iv. 289
and uterus, iv. 288
kidney and duodenum, iv. 288
of larynx, ii. 220
of neck, ii, 17
occlusion of rectum combined with, v. 90
of œsophagus, iv. 29
of parotid duct, i. 612
of pharynx, branchiogenic, i. 877
post-operative, i. 917
salivary, i. 611
duct, i. 612
gland, i. 611
from second branchial cleft, ii. 18
of stomach, iv. 281
of trachea, ii. 220
of urachus, iv. 145
of ureter, v. 378
of urethra, v. 614
urinary, following injuries of bladder, v. 456
of vitello-intestinal duct, iv. 144
Flat-foot, iii. 829
Fœtal clefts, i. 440
Follicular goitre, ii. 315
œsophagitis, iv. 59
Fontanelle, anterior, danger of injury to, in angioma of scalp, i. 47
Foot, ainhum of, iii. 774
aneurism of, iii. 862
angioma of, iii. 870
arthritis deformans of, iii. 785
bones of, inflammations of, iii. 781, 784
tuberculosis of, iii. 785
bursæ of, diseases of, iii. 780
carcinoma of, iii. 872
cellulitis of, iii. 773
chondroma of, iii. 870
clavus of, iii. 774
club-, iii. 800
contracted, iii. 850
contractures of, iii. 795
Foot, dactylolysis of, iii. 774
defects of, iii. 722
deformities of, iii. 795
diseases of, iii. 773
dislocation of, iii. 751
lateral, iii. 752
inward, iii. 754
outward, iii. 752
sagittal, iii. 755
backward, iii. 755
forward, iii. 756
upward, iii. 757
endothelioma of, iii. 871
epithelial cysts in, iii. 871
exostosis in, iii. 870
flat-, iii. 829
gangrene of, iii. 862
gout of, iii. 785
hollow, iii. 850
hypertrophy of, iii. 722
inflammations of, iii. 773
injuries of, iii. 728
joints of, inflammation of, iii. 773
tuberculosis of, iii. 785
leprosy of, iii. 774
lipoma of, iii. 870
lupus of, iii. 774
Madura, iii. 774
malformations of, iii. 722
metatarsal of, dislocations of, iii. 769
fractures of, iii. 768
injuries of, iii. 768
nails of, diseases of, iii. 775
neoplasms of, iii. 870
nerves of, diseases of, iii. 862
neuropathic affections of, iii. 867
operations on, iii. 873
osteoma of, iii. 870
osteosarcoma of, iii. 871
papilloma in, iii. 871
phalanges of, dislocations of, iii. 769
fractures of, iii. 768
injuries of, iii. 768
phlegmon of, iii. 773
rheumatism of, chronic, iii. 784
sarcoma of, iii. 871
sensory disturbances of, iii. 869
skin of, leprosy of, iii. 774
lupus of, iii. 774
syphilis of, iii. 774
tuberculosis of, iii. 774
subungual growths in, iii. 870
syphilis of, iii. 774
syphilitic affections of, skeletal, iii. 785
telangiectasis of, iii. 870
tendon-sheaths of, diseases of, iii. 778
dislocations of, iii. 729
injuries of, iii. 729
lacerations of, iii. 730
transplantation of, iii. 798
trophic disturbances of, iii. 869
tumors of, iii. 768, 870
ulcers of, perforating, iii. 867

Foot, vessels of, diseases of, iii. 862
warts of, iii. 871
Forceps, bladder, with electric lamp, v. 534
factor in producing depressions of cranial bones, i. 22
pressure-marks, i. 18
solution of continuity of cranial bones, i. 23
for removing vesical growths, v. 533
Forearm, amputation of, iii. 259
bones of, fractures of, iii. 246
upper ends of, iii. 189
injuries of, iii. 247
malformations of, iii. 163
osteomyelitis of, iii. 255
tumors of, iii. 257
defects of, iii. 163
malformations of, iii. 163
nerves of, operations on, iii. 261
operations on, iii. 259
paralysis, of, tendon transplantation for, iii. 240
tendons of, diseases of, iii. 233
injuries of, iii. 233
vessels of, diseases of, iii. 234
injuries of, iii. 234
Foreign bodies in abdominal wall, iv. 128
in appendix, iv. 351
in bladder, v. 459
in external auditory canal, i. 351
in hand, iii. 316
in intestine, iv. 279
in nose, i. 755
in œsophagus, iv. 34
in peritoneum, iv. 214
in pharynx, i. 879
in rectum, v. 94
in salivary ducts, i. 618
glands, i. 618
in stomach, iv. 276
in urethra, v. 616
Fractures about the malleoli, iii. 731
of acetabulum, v. 26
of astragalus, iii. 744
of bones of forearm, iii. 246
upper ends of, iii. 189
of pelvis, v. 23
of shaft of leg, iii. 671
butterfly, iii. 139
of calcaneum, iii. 746
of carpal bones, iii. 300
of clavicle, iii. 26
Colles', iii. 286
of costal cartilages, ii. 441
of elbow-joint, iii. 167, 196
of femur, condyles of, iii. 571
epiphyseal lines of, iii. 449
great trochanter of, iii. 448
gunshot, iii. 546
head of, iii. 434
neck of, iii. 435
shaft of, iii. 535
of fibula, iii. 680
Fractures of humerus, iii. 49
anatomical neck of, iii. 50
capitulum of, iii. 188
complicated, iii. 132
condyles of, iii. 177
diacondyloid, iii. 187
epicondyles of, iii. 183
in epiphysis, iii. 52
infratubercular, iii. 52
lower end of, iii. 167
shaft of, iii. 128
supracondyloid, iii. 169
surgical neck of, iii. 54
T and Y fractures, iii. 177
through the tuberosity, iii. 52
tuberosities of, iii. 59
uniting with deformity, iii. 138
upper end of, iii. 49
of hyoid bone, ii. 38
of ilium, v. 28
of jaw, lower, i. 662
upper, i. 657
of larynx, ii. 150
of leg, iii. 671
of malar bone, i. 473
of malleoli, iii. 733
of metacarpals, iii. 306
of metatarsals, iii. 768
of nasal bones, i. 476
of nose, i. 475
of orbit, i. 111
of patella, iii. 573
of penis, v. 631
of phalanges of fingers, iii. 308
of foot, iii. 768
Pott's, iii. 733
of radius, head of, iii. 194
lower end of, iii. 286
neck of, iii. 195
shaft of, iii. 253
and ulna, shaft of, iii. 247
of ribs, ii. 428
of long portion of, ii. 428
of sacrum, v. 27
of scapula, iii. 41
acromion and spine of, iii. 44
angles of, iii. 42
body of, iii. 42
coracoid process of, iii. 45
glenoid portion of, iii. 43
gunshot, iii. 45
surgical neck of, iii. 43
of skull, i. 65
base of, i. 75
before birth, i. 17
bending, i. 74
bursting, i. 74, 75
central depression in, i. 67
comminuted, i. 66
of inner table, gunshot injuries of, i. 120
compound, of vault, i. 97
congenital, i. 23
fissured, i. 66
isolated, of inner table, i. 69

Fractures of skull in newborn, treatment of, i. 25
paralysis of cranial nerves in, i. 91
peripheral depression in, i. 67
ring, i. 77
simple, diagnosis in, i. 81
stellate, i. 67
subcutaneous, diagnosis in, i. 82
suppurating, treatment of, i. 103
transverse, i. 76
of small tarsal bones, iii. 750
of sternum, ii. 421
supramalleolar, iii. 731
of tarsus, iii. 744
of tibia and fibula, iii. 671
shaft of, iii. 671
tuberosities of, iii. 572
of trachea, ii. 155
of ulna, coronoid process of, iii. 189
oleocranon process of, iii. 190
shaft of, iii. 251
of vertebræ, due to compression, ii. 681
isolated, ii. 672
of arches of, ii. 683
of spinous processes of, ii. 683
of transverse processes of, ii. 683
Franks' method of establishing gastric fistula, iv. 421
operation for radical cure of hernia, iv. 514
Franz's method of ligation of vertebral artery, ii. 52
Free bodies in elbow-joint, iii. 213
knee-joint, iii. 621
Freudenberg's prostatic incisor, v. 557
Frontal convolutions, injuries of, i. 258
pneumatocele, i. 40
sinus, empyema of, i. 768
osteoma of, i. 134
Frost-bites of fingers, iii. 332
of hand, iii. 332
Funnel chest, ii. 448
Furuncle, axillary, iii. 80
of face, i. 478
of fingers, iii. 329
of hand, iii. 329
of leg, iii. 684
of lips, i. 479
Furunculosis of anus, v. 98

GALL-BLADDER, adhesions of, iv. 680
atheroma of, iv. 694
carcinoma of, iv. 694
distention of, iv. 669
drainage of, iv. 685
echinococcus of, iv. 694
fibroma of, iv. 694
incision of, iv. 681
myxoma of, iv. 694
palpation of, iv. 670
papilloma of, iv. 694
Gall-bladder, passing probe through, iv. 688
perforation of, iv. 670
removal of, iv. 684
rupture of, iv. 636
sarcoma of, iv. 694
tumors of, iv. 694
Gallstone disease, iv. 665
distention of abdomen from, in intestinal obstruction, iv. 344
pericholecystitis from, iv. 666
Ganglion, Gasserian, removal of, i. 585
of knee, iii. 653
of wrist, iii. 365
Gangrene of appendix, iv. 353
of fingers, iii. 338
of foot, iii. 862
of hand, iii. 338
in intestinal obstruction, iv. 336
of lung, ii. 510
of scrotum, v. 662
of umbilicus, iv. 146
Gangrenous intestine, abdominal incision for, iv. 540
Gasserian ganglion, removal of, i. 585
Gastrectasia, iv. 314
Gastrectomy, iv. 451
Gastric dilatation, acute, iv. 294
after choledochotomy, iv. 693
fistula, iv. 281
spasm, nervous, iv. 315
ulcer, iv. 300
peritonitis from, iv. 179
Gastro-anastomosis, iv. 427
Gastro-duodenostomy, iv. 427
Gastro-enterostomy, iv. 427
for carcinoma of stomach, iv. 382
for ulcer of stomach, iv. 312
Gastro-intestinal fistula, iv. 283
Gastrojejunostomy, iv. 428
Gastrolysis, iv. 411
Gastropexy, iv. 412
Gastroplasty, iv. 427
Gastroplication, iv. 409
Gastrorrhaphy, iv. 412
Gastroscope, use of, iv. 237
Gastrostomy, iv. 414, 416
for carcinoma of stomach, iv. 383
for foreign bodies in œsophagus, iv. 50
for stricture of œsophagus, iv. 86
Gelatinous carcinoma of mammary gland, ii. 588
Genu valgum, iii. 634
varum, iii. 645
Gibney's dressing for sprained ankle, iii. 729
Girard's operation for radical cure of hernia, iv. 516
Gland, inguinal, inflammation of, iii. 522
Glanders of face, i. 500
of nose, i. 776
of pharynx, i. 902
Glands, Cowper's, carcinoma of, v. 623
diseases of, v. 624

Glands, Cowper's, fistula of, v. 624
inflammation of, v. 624
suppuration of, v. 624
mammary, actinomycosis of, ii. 575
adenoma of, ii. 580
angioma of, ii. 580
carcinoma of, ii. 585
chondroma of, ii. 589
congenital malformations of, ii. 562
cysts of, sebaceous, ii. 581
diseases of, ii. 564
echinococcus of, ii. 575
fibro-adenoma of, ii. 578
hypertrophy of, ii. 576
inflammations of, ii. 565
injuries of, ii. 563
lipoma of, ii. 581
myxoma of, ii. 580
neuralgia of, ii. 576
osteoma of, ii. 581
sarcoma of, ii. 581
syphilis of, ii. 575
tuberculosis of, ii. 574
tumors of, ii. 577
prostate, anatomy of, v. 539
anomalies, of, v. 541
calculi of, v. 561
carcinoma of, v. 563
cysts of, v. 564
diseases of, v. 539
examination of, v. 540
fibroma of, v. 562
function of, v. 541
hypertrophy of, v. 545
cystitis due to, v. 497
excentric, v. 548
false passages in, v. 553
removal of vas deferens for, v. 560
urine in, v. 555
inflammation of, v. 542
injuries of, v. 542
sarcoma of, v. 562
stricture of, cystitis due to, v. 497
syphilis of, v. 545
tuberculosis of, v. 545
tumors of, v. 562
salivary, i. 607
suprarenal, functions of, v. 416
tuberculosis of, v. 417
tumors of, v. 417
thyroid, accessory, ii. 313
actinomycosis of, ii. 346
alveolar tumors of, ii. 351
carcinoma of, ii. 347
of cretins, ii. 354
diseases of, ii. 297
echinococcus of, ii. 346
hypertrophy of, ii. 300
inflammations of, ii. 345
injuries of, ii. 344
lues of, ii. 346
metastatic growths of, ii. 346
Glands, thyroid, new-growths of, ii. 347
sarcoma of, ii. 347
syphilis of, ii. 346
tuberculosis of, ii. 345
tuberculous, differentiated from appendicitis, iv. 360
Glandular hypospadias, v. 582
Glans penis, imperforate, v. 570
Glisson's sling, ii. 731
Glossitis, phlegmonous, i. 836
Glossy fingers, iii. 317
Gluck's phonation apparatus, ii. 291
Gluteal aneurism, v. 61
artery, inferior, ligation of, v. 75
stab-wounds of, v. 39
superior, ligation of, v. 75
hernia, iv. 620
Goitre, ii. 297
accessory, ii. 310
colloid, ii. 316
cystic, ii. 318
endolaryngeal, ii. 313
follicular, ii. 315
Goldschmidt's apparatus for talipes equinus, iii. 828
Gonorrhœa, cystitis following, v. 495
Gonorrhœal coxitis, iii. 454
inflammation of rectum, v. 99
tenosynovitis of fingers, iii. 343, 345
ulcers of rectum, v. 99
Gotck's operation for radical cure of hernia, iv. 516
Gout of elbow-joint, iii. 212
of foot, iii. 785
of hand, iii. 348
Gräfe's coin-catcher, iv. 45
Granuloma of ear, i. 386
of nose, i. 775
of umbilicus, iv. 147
Graves' disease, ii. 357
Groin, tumors of, iii. 557
Guérin's method for ulcers of leg, iii. 687
Gumma of mouth, i. 825
of muscles of upper arm, iii. 144
of tongue, i. 825
Gummatous periostitis of skull, i. 151
ulcers of face, i. 496
Gums, fibroma of, i. 694
sarcoma of, i. 694
tumors of, i. 693
Günther's incision, iii. 877
Gussenbauer's method of meloplasty, i. 552
of reflecting nose, i. 805
stapel, iii. 137
Guthrie's prostatic catheter, v. 551
Guyon's bladder syringe, v. 488
incision in lumbar nephrectomy, v. 395
stone-searcher, v. 422

HABITUAL dislocations of shoulder, iii. 76
subluxation of knee, iii. 587
Hæmangioma cavernosum, i. 47

Hæmangioma of chest-wall, cavernous, ii. 465
of face, i. 511
of hand, iii. 367
of neck, ii. 130
of thigh, iii. 557
Hæmarthrosis of knee, iii. 566
Hæmatocele of spermatic cord, acute, v. 682
chronic, v. 685
Hæmatoma of axilla, iii. 82
of scalp, i. 28
of septum of nose, i. 750
of spermatic cord, v. 668
subdural, i. 209
of testicle, v. 668
Hæmatomyelia, ii. 630
Hæmaturia, significance of, v. 235
Hæmophilia, knee-joint in, iii. 615
renal, v. 342
Hæmothorax, ii. 486
Hall's operation for radical cure of hernia, iv. 508
Hallux valgus, iii. 851
varus, iii. 855
Hamilton's extension splint, iii. 131
Hammer-toe, iii. 856
Hand, acute inflammatory processes of, iii. 321
amputation of, iii. 377
ankylosis of, iii. 356
bones of, acromegaly of, iii. 351
diseases of, iii. 346
inflammations of, iii. 346
tuberculosis of, iii. 351
burns of, iii. 332
bursæ of, diseases of, iii. 342
carcinoma of, iii. 367, 373
cavernoma of, iii. 367
cellulitis of, iii. 322
cicatricial contraction of, iii. 319
cirsoid aneurism of, iii. 368
congenital hypertrophy of, iii. 270
contractures of, iii. 356
deformities of, iii. 356
development of, iii. 270
enchondroma of, iii. 370
erysipelas of, iii. 330
exarticulation of, iii. 377
fibroma of, iii. 369
foreign bodies in, iii. 316
frost-bites of, iii. 332
furuncle of, iii. 329
gangrene of, iii. 338
gout of, iii. 348
hæmangioma of, iii. 367
joints of, arthritis deformans of, iii. 348
diseases of, iii. 346
gonorrhœa of, iii. 346
gout of, iii. 348
inflammation of, iii. 346
neuropathic arthritis of, iii. 350
rheumatism of, iii. 346
suppuration of, iii. 347
Hand, joints of, syphilis of, hereditary, iii. 349
traumatic effusion of, iii. 347
leprosy in, local effects of, iii. 337
lipoma of, iii. 368
lymphangitis of, iii. 331
malformations of, iii. 270
moles of, iii. 367
nævus pigmentosus of, iii. 367
neoplasms of, iii. 365
neuroma of, iii. 370
neuropathic arthritis of, iii. 350
operations on, iii. 374
osteoma of, iii. 372
phlebitis of, iii. 331
phlegmonous processes of, iii. 321
post-traumatic neuritis of, iii. 318
periostitis of, iii. 320
pseudoerysipelas of, iii. 330
sarcoma of, iii. 372
sebaceous cysts of, iii. 369
skin of, tuberculosis of, iii. 333
soft parts of, infections of, iii. 329
syphilis of, iii. 331
hereditary, iii. 349
syphilitic affections of, iii. 336
syringomyelia in, local effects of, iii. 337
telangiectasis of, iii. 367
tendons of, dislocations of, iii. 280
open division of, iii. 282
operations on, iii. 283
plastic, iii. 375
sheaths of, iii. 265
diseases of, iii. 342
subcutaneous laceration of, iii. 281
suture of, iii. 283
tenosynovitis of, iii. 343
traumatic changes in joints of, iii. 319
trophic disturbances of, iii. 337
tumors of, iii. 365
warts of, iii. 367
wounds of, iii. 314
Harelip, i. 416
operations for, i. 425
Bruns' curved incision in, i. 431
modification of Malgaigne's incision, i. 427
of Mirault's incision, i. 428
Dieffenbach's incision in, i. 431
double, i. 432
Gräfe's method, i. 426
Hagedorn's method, i. 430
modification of König's incision, i. 429
König's incision, i. 429
Maas' modification of Mirault's method, i. 428
Nélaton's incision, i. 427
Simon's nostril flaps, i. 436
Wolf's modification of Langenbeck's incision, i. 429

Hartley's operation for removal of Gasserian ganglion, i. 585
Head, injuries of, i. 17
tetanus of, i. 500
Heart, injuries of, ii. 403
operations on, ii. 553
surgical diseases of, ii. 548
Hedrocele, iv. 621
Heidenhain's traction loop for talipes equinus, iii. 828
Heineke-Mikulicz pyloroplasty, iv. 423
Helferich's method of ligation of vertebral artery, ii. 53
Hemianopsia, i. 261
Hemimelia, iii. 117
Hemiplegia, i. 253
alternans superior, i. 261
in cerebral hemorrhage, i. 214
Hemorrhage, abdominal, iv. 156
angioneurotic, v. 342
of bladder, from tumor, v. 310
after choledochotomy, iv. 693
after laparotomy, iv. 226
control of, in scalp-wounds, i. 35
cysts of spleen due to, iv. 704
from external auditory meatus in fracture of base of skull, i. 88
intermeningeal, during labor, i. 22
intestinal, after thrombosis of mesentery, iv. 329
of kidneys, due to tumors, v. 351
into mediastinum, ii. 540
of middle meningeal artery, i. 209
from movable kidney, v. 341
of nose, i. 757
of œsophagus, iv. 33
of pancreas, iv. 719
in pregnancy, v. 341
from rectum, v. 92
renal, v. 329
essential, v. 340
from rupture of liver, iv. 633
subdural, i. 228
of tongue, from wounds of, i. 812
from traumatisms of kidney, v. 342
into tunica vaginalis, v. 669
from ulcer of duodenum, iv. 316
of stomach, iv. 303
in uronephrosis, v. 341
Hemorrhagic pancreatitis, iv. 722
periorchitis, v. 682
perispermatitis, v. 684
Hemorrhoids, v. 124
Hennequin's bone-suture, iii. 136
Hensner's apparatus for fractured clavicle, iii. 31
Hepatic artery, aneurism of, iv. 657
duct, drainage of, iv. 688
Hepatoptosis, iv. 657
Hernia, iv. 483, 564
in abdominal scars, iv. 614
of bladder, v. 464
cerebri, i. 273
congenital, iv. 591
of cord, iv. 593
Hernia, congenital inguinal, iv. 560
diaphragmatic, iv. 624
deforce, iv. 488
fatty, iv. 495
femoral, iv. 576
of floor of pelvis, iv. 621
following appendicitis, iv. 365
gluteal, iv. 620
immovable, iv. 498
inflammation of, iv. 520
inguinal, iv. 548
interstitial, iv. 557
of intestinal wall, iv. 593
irreducible, iv. 498
labial, iv. 560
lateral, iv. 493
in linea alba, iv. 611
lumbar, iv. 616
of lung, ii. 455
of muscles of arm, iii. 119
obturator, iv. 605
perineal, iv. 621
radical cure of, iv. 507
operations for, iv. 504
scrotal, iv. 556
strangulated, iv. 521
of thigh, iii. 534
umbilical, iv. 593
ventral, iv. 609
vesical, v. 464
Hernial contents, iv. 492
reduction, iv. 533
ring, iv. 490
sac, iv. 490
Herniotomy, iv. 535
Herpes tonsillaris, i. 885
Hessing's corset, ii. 741
Hey's catheter for prostatic hypertrophy, v. 552
High shoulder, iii. 17
Hip, bursæ of, inflammation of, iii. 519
diseases of, iii. 452
dislocation of, iii. 416
backward, iii. 417
bilateral, iii. 432
centrally, iii. 431
congenital, iii. 389
downward, iii. 429
forward, iii. 424
iliac, iii. 417
infrapubic, iii. 424
sciatic, iii. 418
suprapubic, iii. 424
upward, iii. 430
voluntary, iii. 432
injuries of, iii. 416
-joint, amputation of, iii. 527
ankylosis of, iii. 502
arthritis deformans of, iii. 494
contracture of, iii. 502
coxitis from acute osteomyelitis, iii. 458
by direct infection, iii. 456
following infectious disease, iii. 453

Hip-joint, coxitis, gonorrhœal, iii. 454
in infancy, iii. 455
rheumatism of, iii. 453
deformities of, paralytic, iii. 510
dislocation of, paralytic, iii. 510
hysterical, iii. 501
inflammation at, iii. 452
loose, iii. 510
neuralgia of, iii. 501
neuropathic affections of, iii. 501
resection of, iii. 524
of syringomyelia, iii. 501
of tabes, iii. 501
tuberculosis of, iii. 463
wounds of, gunshot, iii. 450
malformations of, iii. 389
operations on, iii. 524
Hoffa's apparatus for talipes calcaneus, iii. 849
Hofmeister's dressing for dislocation of clavicle, iii. 37
method for forward dislocation of shoulder, iii. 69
Höftmann's prothesis for thigh, iii. 564
Holden's toe-post, iii. 854
Hollow-foot, iii. 850
Horns, cutaneous, of face, i. 521
Hour-glass stomach, iv. 294
Housemaid's knee, iii. 650
Hudson's apparatus for talipes equinus, iii. 828
Humerus, aneurism of, iii. 151
carcinoma of, iii. 154
echinococcus of, iii. 151
enchondroma of, iii. 150
exostosis of, iii. 150
fractures of, iii. 49
anatomical neck of, iii. 49
capitulum of, iii. 188
complicated, iii. 132
condyles of, iii. 177
external, iii. 181
internal, iii. 186
diacondyloid, iii. 187
epicondyles of, iii. 183
in epiphysis, iii. 52
infratubercular, iii. 52
lower end of, iii. 167
shaft of, iii. 128
supracondyloid, iii. 169
surgical neck of, iii. 54
T and Y fractures, iii. 177
through the tuberosity, iii. 52
tuberosities of, iii. 59
uniting with deformity, iii. 138
upper end of, iii. 49
osteomyelitis of, iii. 147
pseudarthrosis of, iii. 134
resection of, iii. 157
sarcoma of, iii. 151
syphilis of, iii. 149
tuberculosis of, iii. 149
tumors of, iii. 149
Hydatid cyst of liver, iv. 643
of Morgagni, cyst of, v. 707
Hydradenitis axillaris, iii. 80
Hydrocele, iv. 564
of spermatic cord, acute, v. 672
bilocular, v. 676
chronic, v. 673
congenital, v. 676
diffuse, v. 686
multilocular, v. 686
Hydrocephalus, acute, i. 202
chronic, acquired, i. 203
idiopathic, i. 203
congenital, i. 173
Hydrodynamic action in gunshot-wounds of skull, i. 115
Hydronephrosis, v. 261
Hydrops, intermittent, of knee-joint, iii. 599
Hydrothorax, ii. 486
Hygroma of thigh, iii. 557
Hyoid bone, diseases of, ii. 38
fracture of, ii. 38
inflammation of, ii. 39
tumors of, ii. 39
Hypernephroma of kidney, v. 361
Hyperplasia of thymus, ii. 363
Hyperplastic lymphoma, simple, ii. 89
Hypertrophy, of bladder, result of cystitis, v. 476, 482
congenital, of foot, iii. 722
of hand, iii. 270
of mammary gland, ii. 576
of œsophagus in stricture, iv. 67
of prostate, v. 545
cystitis due to, v. 497
excentric, v. 548
false passages in, v. 553
removal of vas deferens for, v. 560
of spleen, iv. 708
of thyroid gland, diffuse, ii. 300
partial, ii. 300
of tonsils, i. 894
Hypopharynx, atresia of, i. 903
benign tumors of, i. 909
Hypospadias, v. 581
glandular, v. 582
penile, v. 583
scrotal, v. 584
Hysterical hip-joint, iii. 501
shoulder-joint, iii. 102

IDIOCY of cretins, ii. 353
Ileostomy, iv. 456
Ileus, dynamic, iv. 331
mechanical, iv. 332
Iliac artery, common, ligation of, v. 75
external, ligation of, v. 75
internal, ligation of, v. 75
Ilium, fracture of, v. 28
Immovable hernia, iv. 498
Imperforate anus, v. 83
glans penis, v. 570
Indirect inguinal hernia, iv. 555
Inflammations of abdominal wall, iv. 129
of accessory nasal sinuses, i. 759

Inflammations of ankle, iii. 773
-joint, iii. 781
of appendix, iv. 350
of biliary passages, iv. 663
of bladder, v. 470
of bones of foot, iii. 781
of hand, iii. 346
of breast, specific, ii. 574
of bursæ of hip, iii. 519
of Cowper's glands, v. 624
of elbow-joint, iii. 210
of epididymis, acute, v. 694
of foot, iii. 773
of goitre, ii. 344
of hernia, iv. 520
of hip-joint, iii. 452
of hyoid bone, ii. 39
of inguinal glands, iii. 522
of joints of foot, iii. 781
of hand, iii. 346
of kidney, chronic, v. 316
suppurative, v. 283
of knee-joint, acute exudative, iii. 594
chronic deforming, iii. 619
of larynx, specific, ii. 204
of membranes of spermatic cord, chronic, v. 673
of metatarsal bones, iii. 783
of metatarsals in infectious diseases, iii. 784
of nasopharynx, i. 778, 880
of neck, ii. 75
of nose, i. 758
of œsophagus, iv. 59
of pancreas, iv. 719
of penis, v. 637
in periproctal connective tissue, v. 106
of peritoneum, iv. 160
of prostate, v. 542
of rectum, v. 97, 98
gonorrhœal, v. 99
and its neighborhood, v. 97
of salivary ducts, i. 625
glands, i. 624
of scrotum, v. 661
of seminal vesicles, v. 719
in sheath of rectus muscle, iv. 130
submental, ii. 83
surrounding great vessels, ii. 83
of testicle, acute, v. 694
of thorax, ii. 453
of tibiotarsal joint, iii. 781
of tonsils, i. 880
of trachea, specific, ii. 204
of tunica vaginalis, v. 670
of umbilicus, iv. 146
of ureters, v. 389
of vascular space, ii. 83
Inflammatory diseases of larynx, ii. 175
of shoulder-joint, iii. 89
of trachea, ii. 175
disorders of intestine, iv. 276
of stomach, iv. 276
Inflammatory infections of pelvis, v. 45
processes of axilla, iii. 80
of fingers, acute, iii. 321
of hand, acute, iii. 321
of mediastinum, ii. 530
of thigh, iii. 551
and ulcers of soft parts of leg, iii. 684
strictures of urethra, v. 599
Infraungual bursitis, iii. 651
Infrapapillar stenosis of intestine, iv. 299
Infusion at elbow, iii. 235
Ingrowing toe-nail, iii. 776
Inguinal adenitis, iii. 522
aneurism, v. 59
glands, inflammation of, iii. 522
hernia, iv. 548
region, tumors of, iii. 557
Inguinoproperitoneal hernia, iv. 574
Initial lesion of skin, i. 495
Injection-therapy in treatment of goitre, ii. 321
Innominate artery, arterial aneurism of, ii. 70
ligation of, ii. 54
vein, ligation of, ii. 61
Intercostal neuralgia, ii. 460
Intermittent hydrops of knee-joint, iii. 599
uronephrosis, v. 276
Interparietal inguinal hernia, iv. 573
Interscapulothoracic amputation of shoulder, iii. 112
Interstitial cystitis, v. 482
hernia, iv. 557
pancreatitis, chronic, iv. 725
Intertrigo, v. 97
Intestinal fistula, iv. 283, 287
hemorrhage from thrombosis of mesentery, iv. 329
wall, hernia of, iv. 493
Intestine, abnormal length of, iv. 252
absence of mesentery, iv. 252
acquired diverticula of, iv. 252
actinomycosis of, iv. 325
adenoma of, iv. 384
carcinoma of, iv. 390
congenital anomalies of, iv. 249
displacement of, iv. 252
elimination of, iv. 478
escape of fluids from, iv. 258
examination of, iv. 233
fecal tumor of, iv. 281
fistula of, iv. 463
foreign bodies in, iv. 279
gangrenous, abdominal incision for, iv. 540
inflammatory disorders of, iv. 276
injuries of, iv. 253
large, injuries of, iv. 273
ligation of, iv. 401
lipoma of, iv. 385
Meckel's diverticulum, iv. 249
myoma of, iv. 386
obstruction of, iv. 331

Intestine, operations on, iv. 358, 453
perforation of, test for, iv. 156
resection of, iv. 468
sarcoma of, iv. 389
sigmoid, volvulus of, iv. 341
small, injuries of, iv. 270
stenosis of, chronic, iv. 295
congenital, iv. 251
tuberculosis of, iv. 323
suture of, iv. 398, 454
traumatic perforation of, iv. 255
tuberculosis of, iv. 320
tumors of, iv. 385
ulcers of, iv. 317
wounds of, iv. 263
Intracranial vessels, injuries of, i. 205
Intrameningeal hemorrhage during labor, i. 22
Intramesenteric suture, iv. 479
Inthrathoracic vessels, large, injuries of, ii. 417
Intrauterine fracture of leg, iii. 670
injuries of head, medico-legal significance of, i. 17
Intravaginal spermatocele, v. 711
Intubation of larynx, ii. 184
Intussusception of intestine, obstruction from, iv. 335
from myoma, iv. 387
Invagination of intestine, obstruction from, iv. 335
Irreducible hernia, iv. 498
Ischias scoliatica, ii. 799
Ischiorectal abscess, v. 107

JAUNDICE, forms of, iv. 663
in hydatid cyst of liver, iv. 647
in sinus thrombosis, i. 293
Jaw, actinomycosis of, i. 673
angle of, abscess at, ii. 83
articular ankylosis of, i. 715
artificial, Martin's, i. 721
repair of, after resection, i. 720
Stoppany's, i. 724
carcinoma of, i. 707
chondroma of, i. 701
cystoma of, i. 699
disarticulation of, i. 720
diseases of, i. 673
fibroma of, i. 700
fracture of, i. 657
inflammation of, in pearl-carvers, i. 688
in tabes, i. 688
injuries of, i. 657
lower, dislocation of, i. 670
fractures of, i. 662
resection of, i. 719
for carcinoma of tongue, i. 872
osteoplastic, i. 725
odontoma of, i. 696
operation on, i. 719
osteoma of, i. 702
osteomyelitis of, i. 691
Jaw, osteomyelitis of, in pearl-carvers, i. 688
periostitis of, i. 689
in pearl-carvers, i. 688
resection of, temporary, i. 725
sarcoma of, i. 703
syphilis of, i. 679
tuberculosis of, i. 676
tumors of, i. 693
of body, i. 696
upper, fractures of, i. 657
resection of, i. 725
osteoplastic, i. 732
partial, i. 725
Jejunostomy, iv. 455
for carcinoma of stomach, iv. 383
for ulcer of stomach, iv. 310
Jejunum, ulcer of, iv. 315
Jobert's method of suture of intestine, iv. 398
Joints, ankle-, amputation of, iii. 873
inflammation of, iii. 781
injuries of, iii. 728
complicated, iii. 766
compound, iii. 766
resection of, iii. 880
sprains of, iii. 728
synovitis of, iii. 781
Chopart's, iii. 717
elbow-, amputation at, iii. 226
arteries at, ligation of, iii. 227
arthritis deformans of, iii. 212
contusions of, iii. 166
diseases of, iii. 210
dislocations of, iii. 198
backward, iii. 199
diverging, iii. 206
forward, iii. 206
lateral, iii. 204
of radius at, iii. 207
of ulna at, iii. 207
fractures of, iii. 167
complicated, iii. 196
gunshot, iii. 196
free bodies in, iii. 213
gout of, iii. 212
inflammations of, iii. 210
injuries of, iii. 166
loose, iii. 225
nerves at, location of, iii. 227
operations on, iii. 222
resection of, iii. 222
sprains of, iii. 166
suppuration of, iii. 211
syphilis of, iii. 211
tuberculosis of, iii. 215
wounds of, gunshot, iii. 197
of fingers, diseases of, iii. 346
traumatic changes in, iii. 319
of foot, inflammations of, iii. 781
tuberculosis of, iii. 785
of hand, arthritis deformans of, iii. 348
diseases of, iii. 346
gonorrhœa of, iii. 346

Joints, of hand, gout of, iii. 348
inflammations of, iii. 346, 348
neuropathic arthritis of, iii. 350
rheumatism of, iii. 346
suppuration of, iii. 347
syphilis of, hereditary, iii. 349
traumatic effusion in, iii. 347
hip-, amputation of, iii. 527
ankylosis of, iii. 502
arthritis deformans of, iii. 494
contractures of, iii. 502
coxitis from acute osteomyelitis, iii. 458
by direct infection, iii. 456
following infectious diseases, iii. 453
gonorrhœal, iii. 454
in infancy, iii. 455
rheumatism of, acute articular, iii. 455
syphilitic, iii. 455
traumatic, iii. 453
typhoid, iii. 455
deformities of, paralytic, iii. 510
dislocation of, paralytic, iii. 510
hysterical, iii. 501
inflammation at, iii. 452
loose, iii. 510
neuropathic affections of, iii. 501
resection of, iii. 524
of syringomyelia, iii. 501
of tabes, iii. 501
tuberculosis of, iii. 463
wounds of, gunshot, iii. 450
knee-, ankylosis of, iii. 626
contracture of, iii. 626
deformities of, paralytic, iii. 633
static, iii. 634
free bodies in, iii. 621
hæmophilia in, iii. 615
inflammations of, acute exudative, iii. 594
chronic deforming, iii. 619
intermittent hydrops of, iii. 599
neoplasms of, iii. 648
neuralgia of, iii. 624
neuropathic affections of, iii. 624
neurosis of, iii. 624
rheumatism of, iii. 618
synovitis of, iii. 594
syphilis of, iii. 617
of syringomyelia, iii. 625
of tabes, iii. 625
tuberculosis of, iii. 600
tumors of, iii. 648
Valleix's pressure-points in, iii. 624
wounds of, iii. 568
mediotarsal, amputation in, iii. 877
metacarpophalangeal, tuberculosis of, iii. 356
metatarsal, dislocation in, iii. 765
metatarsophalangeal, resection of, iii. 887
of pelvis, tuberculosis of, v. 50
Joints, shoulder-, ankylosis of, iii. 89
contracture of, iii. 89
contusions of, iii. 46
diseases of, iii. 89
hysterical, iii. 102
loose, iii. 100
neuroses of, iii. 102
resection of, iii. 106
sprains of, iii. 44
wounds of, iii. 46
of tarsus, suppuration of, iii. 781
tibiotarsal, inflammations of, iii. 781
resection of, iii. 880
of toes, inflammations of, iii. 781
resection of, iii. 887
of wrist, tuberculosis of, iii. 351
Jordan's method of blepharoplasty, i. 559
of splitting nose, i. 803
Jugular vein, internal, arteriovenous aneurism of, ii. 73, 75
ligation of, i. 304; ii. 59
Jury mast, ii. 737

KADER'S method of establishing gastric fistula, iv. 420
Kelly's proctoscope, v. 80
ureteral catheterization, v. 196
Keloids of chest-wall, ii. 461
of ear, i. 387
of face, i. 506
Kelsey's pile-clamp, v. 133
Kentrotribe of Mikulicz, iv. 465
Kidneys, abscess of, v. 258
absence of one, v. 218
actinomycosis of, v. 348
adenocystoma of, v. 368
adenoma of, v. 353
anatomical characteristics of, v. 175
angiosarcoma of, v. 358
arterial supply of, v. 182
calculus of, v. 293
carcinoma of, v. 355
congenital abnormalities of, v. 218
cortex of, tumors of, v. 364
cystic teratoma of, v. 372
cysts of, echinococcus, v. 366
paranephritic, v. 372
simple, v. 367
solitary, v. 371
diseases of, v. 245
embryonic adenosarcoma of, v. 360
endothelioma of, v. 358
epithelioma of, v. 358
examination of, v. 186
extirpation of, clinical results of, v. 406
fibroma of, v. 353
fistula of, to obtain urine, v. 211
functional activity of, v. 216
hypernephroma of, v. 361
infection of, v. 283
inflammation of, chronic, v. 316
suppurative, v. 283
injuries of, v. 223
open wounds, v. 241

Kidneys, injuries of, without open wounds, v. 229
lipoma of, v. 353
morcellement of, v. 401
movable, v. 245
neuralgia of, v. 344
normal support of, v. 126
operations on, v. 393
pelvis of, incision into, v. 185
primary new growths of, v. 373
tumors of, v. 349
perithelioma of, v. 358
polycystic degeneration of, v. 367
relations of, v. 175
resection of, v. 410
rupture of, v. 232
sarcoma of, v. 358
suppurative dilatation of, v. 283
syphilis of, v. 347
traumatisms of, hemorrhage from, v. 342
tuberculosis of, v. 316
tumors of, v. 349
benign, v. 353
cystic, v. 366
malignant, v. 355
retention, v. 258
wounds of, gunshot-, v. 242
incised, v. 241
stab-, v. 241
Killian and Barth's method of reflecting nose, i. 805
Kirstein's direct laryngoscopy, i. 879, 912
Knee, amputations at, iii. 713
bursæ of, diseases of, iii. 649
contusions of, iii. 565
deformities of, iii. 633
diseases of, iii. 594
dislocations of, iii. 582
backward, iii. 583
forward, iii. 583
menisci of, iii. 591
sideways, iii. 584
habitual subluxation of, iii. 587
hæmarthrosis of, iii. 566
injuries of, iii. 565
-joint, ankylosis of, iii. 626
contracture of, iii. 626
deformities of, iii. 633
free bodies in, iii. 621
hæmophilia in, iii. 615
inflammations of, acute exudative, iii. 594
chronic deforming, iii. 619
intermittent hydrops of, iii. 599
neoplasms of, iii. 648
neuralgia of, iii. 624
neuropathic affections of, iii. 624
neurosis of, iii. 624
rheumatism of, iii. 618
synovitis of, iii. 594
syphilis of, iii. 617
of syringomyelia, iii. 625
of tabes, iii. 625
tuberculosis of, iii. 600
Knee-joint, tumors of, iii. 648
Valleix's pressure-points in, iii. 624
wounds of, iii. 568
menisci of, dislocation of, iii. 591
neoplasms of, iii. 646
snapping, iii. 633
sprains of, iii. 565
tumors of, iii. 646
Knock-knees, iii. 634
Kocher's amputation of shoulder, iii. 109
coxa vara, iii. 513
method for forward dislocation of shoulder, iii. 66
of ligation of vertebral artery, ii. 52
operation for radical cure of hernia, iv. 516
resection of ankle-joint, iii. 883
subcortical resection of shoulder-joint, iii. 106
Kölliker's splint for club-foot, iii. 814
Kollmann's urethrometer and dilator, v. 604
urethrotome, v. 611
König's incision in nephrectomy, v. 398
method for club-foot, iii. 817
operation for saddle-nose, i. 531
plates for dislocated clavicle, iii. 39
resection of ankle-joint, iii. 882
spiral canula, ii. 260
splint for club-foot, iii. 813
Körner's method of restoration of auditory canal after radical operation, i. 406
Kramer's incision for thrombosed veins, iii. 694
Kraske's operation for radical cure of hernia, iv. 516
resection of rectum, v. 159
Krause's operation for removal of Gasserian ganglion, i. 585
Kyphosis, ii. 769

LABIAL hernia, iv. 560
Labor, depression of cranial bones during, i. 22
importance of course of, in injuries of head in newborn, i. 24
intermeningeal hemorrhage during, i. 22
Labyrinth disease, i. 371, 376
Laceration of corpora cavernosa, v. 632
of tendons of foot, iii. 730
of urethra, v. 589
Lachrymal and salivary glands, symmetrical disease of, i. 636
Laminectomy, bone forceps for, ii. 642
with opened dura, ii. 643
Landerer's pad for varicose veins, iii. 693
Langenbeck's amputation of shoulder, iii. 109
lateral pharyngotomy, i. 916
method of cheiloplasty, i. 549
of resection of nose, i. 804
needle-holder, i. 450

Langenbeck's pile-clamp, v. 133
resection of ankle-joint, iii. 880
of shoulder-joint, iii. 106
Lang's treatment of inguinal adenitis, iii. 522
Laparotomy, iv. 201
Laryngeal cartilages, dislocation of, ii. 149
Laryngismus stridulus in rhachitis, i. 130
Laryngitis, hypoglottica, ii. 197, 199
submucosa, ii. 195
Laryngocele, ii. 147
Laryngotomy, ii. 276
Laryngotracheotomy, ii. 277
Larynx, actinomycosis of, ii. 209
angioma of, ii. 227
artificial, ii. 288
burns of, ii. 162
carcinoma of, ii. 236
concussion of, ii. 149
contusions of, ii. 149
excision of, ii. 282
fibromata of, ii. 225
fistulas of, ii. 220
fracture of, ii. 150
inflammations of, specific, ii. 204
inflammatory diseases of, ii. 175
intubation of, ii. 184
leprosy of, ii. 211
lipoma of, ii. 227
lupus of, ii. 207
malformations of, ii. 145
myxomata of, ii. 227
neuroses of, ii. 223
new-growths of, ii. 225
œdema of, ii. 195
papillomata of, ii. 226
sarcoma of, ii. 233
stenosis of, ii. 211
syphilis of, ii. 207
tuberculosis of, ii. 204
tumors of, ii. 225, 233
wounds of, ii. 157
Lateral hernia, iv. 493
Le Fort's operation for exstrophy of bladder, v. 433
Leg, amputation of, iii. 713
aneurism in, iii. 689
arteries of, ligation of, iii. 715
bones of, shaft of, fractures of, iii. 671
syphilis of, iii. 705
tuberculosis of, iii. 703
tumors of, iii. 710
cellulitis of, iii. 684
diseases of, iii. 684
eczema of, iii. 684
elephantiasis of, iii. 695
erysipelas of, iii. 684
fractures of, iii. 671
furuncle of, iii. 670
injuries of, iii. 671
malformations of, iii. 669
osteomyelitis of, acute, iii. 697
phlegmon of, iii. 684
pseudarthrosis of, iii. 682
Leg, rhachitic curvatures of, iii. 706
soft parts of, neoplasms of, iii. 709
tumors of, iii. 709
ulcers of, iii. 684
varicose veins of, iii. 690
Lembert's method of suture of intestine, iv. 398
Lennander's operation for inguinal glands, iii. 560
Lenticular nucleus, injuries of, i. 261
Leontiasis of cranial bones, i. 139
Leprosy of fingers, effects of, iii. 337
of foot, iii. 774
of hand, effects of, iii. 337
of larynx, ii. 211
of nose, i. 776
of pharynx, i. 901
of testicle, v. 707
Leptomeningitis, i. 250
Leroy's catheter for prostatic hypertrophy, v. 551
Leucoplakia of mouth, i. 833
Leukæmia, spleen in, iv. 708
Leukoplakia, i. 524
Lids, plastic operations on, i. 556
Ligamentum patellæ, rupture of, iii. 581
Ligation of arteries of leg, iii. 715
in neck, ii. 44
in scalp-wounds, i. 35
of axillary artery, iii. 105
of brachial artery, iii. 156
of carotid artery, preliminary, i. 726
of cubital artery, iii. 227
of femoral artery, iii. 559
of gluteal artery, inferior, v. 75
superior, v. 75
of iliac artery, common, v. 75
external, v. 75
internal, v. 75
of innominate vein, ii. 61
of intestine, iv. 401
of jugular vein, ii. 59
of lingual artery, ii. 50
of pelvic arteries, v. 73
of pudic artery, internal, v. 75
of radial artery, iii. 259
at wrist, iii. 375
of saphenous vein, Trendelenburg's, iii. 694
of subclavian artery, ii. 53; iii. 22
vein, ii. 60; iii. 104
of thyroid artery in treatment of goitre, ii. 339
of ulnar artery, iii. 259
at wrist, iii. 375
of veins of neck, ii. 59
of vertebral artery, ii. 51
of vessels of kidney, v. 400
of thigh, iii. 575
Ligature-carrier, v. 135
Linea alba, hernia in, iv. 611
semicircularis, hernia in, iv. 614
Lingual artery, ligation of, ii. 50
Linhart's method of reflection of nose, i. 804

Membrana tympani, inflammation of, i. 364
injuries of, i. 354
Membranes of cord, diseases and injuries of, ii. 625
Membranous cystitis, v. 476
Meninges, laceration of, i. 242
Meningitis, basilar, following fracture of base of skull, i. 106
following cephalhæmatoma in newborn, i. 21
erysipelas of scalp, i. 63
serous, i. 203
traumatic, i. 270
Meningocele associated with lymphangiomata, v. 20
with teratomata, v. 20
pure, v. 20
sacrococcygeal, v. 17
sacrolumbar, v. 17
spuria, i. 83
Menisci of knee, dislocation of, iii. 591
Menoplegia, i. 253
Mental diseases following cranial injuries, i. 312
Mercier's catheter for prostatic hypertrophy, v. 551
Mesentery, absence of, iv. 252
embolism of, iv. 328
injuries of, iv. 272
thrombosis of, iv. 328
tumors of, iv. 196
Mesopharynx, atresia of, i. 903
tumors of, i. 905, 908
Metacarpals, amputation of, iii. 377
fracture of, iii. 306
resection of, iii. 384
sequestrotomy of, iii. 384
tuberculosis of, iii. 354
Metacarpophalangeal joint, tuberculosis of, iii. 309
Metacarpus, dislocation of, iii. 309
Metapneumonic empyema, ii. 483
Metastasis in carcinoma of stomach, iv. 375
Metatarsalgia, iii. 857
Metatarsals, amputation of, iii. 879
dislocation of, iii. 770
fractures of, iii. 768
inflammation of, in infectious diseases, iii. 784
joint, dislocation in, iii. 765
osteomyelitis of, iii. 784
and phalanges, dislocation of, iii. 768
fractures of, iii. 768
resection of, iii. 887
rheumatism of, iii. 784
Metatarsophalangeal joints, resection of, iii. 887
Metatarsus, bones of, inflammation of, acute, iii. 783
dislocation of, total, iii. 769
injuries of, iii. 769
joints of, inflammation of, acute, iii. 783
Metatarsus and toes, injuries of, iii. 768
Middeldorpf's triangle, iii. 130
Mikulicz's disease, i. 636
enterotribe, iv. 402
gauze tampon, iv. 219
method of gastro-enterostomy, iv. 442
Milianos' varicocele compressor, v. 690
Moles of hand, iii. 367
Monobrachia, iii. 117
Morgagni, hydatid of, cyst of, v. 707
Morris' endoscopic tube, v. 200
Morton's neuralgia, iii. 857
symptom-complex, ii. 869
Mosetig's bone-filling for cavities, iii. 702
Mothe's method for forward dislocation of shoulder, iii. 68
Motor area, injuries of, i. 254
region, i. 252
Mouth, actinomycosis of, i. 830
angioma of, i. 840
carcinoma of, i. 862
congenital diseases of, i. 807
dermoids of, i. 852
floor of, carcinoma of, treatment of, i. 875
gumma of, i. 825
injuries of, i. 810
leukoplakia of, i. 833
lymphangioma of, i. 843
malformations of, i. 807
plastic operations on, i. 551
syphilis of, i. 823
tuberculosis of, i. 827
tumors of, i. 840
cystic, i. 847
wounds of, i. 810
Movable kidney, v. 245
spleen, iv. 710
Mucous cysts of face, i. 521
polyps of rectum, v. 146
Multilocular cystoma, v. 710
echinococcus of liver, iv. 652
hydrocele of spermatic cord, v. 686
spermatocele, v. 709
Multiple villous papilloma of bladder, v. 522
Mumps, i. 626
Murphy button, iv. 404
in end-to-end anastomosis, iv. 471
use of, for gastro-enterostomy, iv. 436
Muscle, rectus, inflammation in sheath of, iv. 130
Muscles of thigh, diseases of, iii. 521
hernia of, iii. 534
injuries of, iii. 533
rupture of, iii. 533
tumors of, iii. 557
of upper arm, abscess of, iii. 144
angioma of, iii. 144
diseases of, iii. 144
gumma of, iii. 144
hernia of, iii. 119

Muscles of upper arm, injuries of, iii. 118
ossification of, iii. 144
rupture of, iii. 119
Muscular contraction in peritonitis, iv. 170
wry-neck, ii. 26
Musculospiral nerve, injuries of, iii. 124
paralysis of, iii. 133
Myeloceles, associated with cavernous tumors, v. 20
with cystic lymphangioma, v. 20
with lipoma, v. 20
Myelocystocele, ii. 655
Myelo-cysto-meningocele, ii. 661
Myelogenous sarcoma of jaw, i. 704
Myelomeningocele, ii. 653
Myogenic contractures, ii. 37
Myoma of bladder, v. 524
of intestine, iv. 386
of œsophagus, iv. 106
Myositis, syphilitic, of upper arm, iii. 144
Myxœdema, ii. 355
Myxoma of biliary passages, iv. 694
of bladder, v. 524
of ear, i. 390
of femur, iii. 556
of gall-bladder iv. 694
intracanaliculare, ii. 578
of mammary gland, ii. 580
of salivary glands, i. 644

NÆVI of chest-wall, ii. 461
subcutaneous, i. 45
Nævus, flat pigmented, i. 502
pigmentosus of hand, iii. 367
Nasal bones, fracture of, i. 476
cartilage, displacement of, i. 746
framework, fracture of, i. 476
hemorrhages, i. 757
saws, i. 753
sinuses, accessory, inflammation of, i. 759
Nasopharynx, carcinoma of, i. 797
dermoids of, i. 795
endothelioma of, i. 796
fibroma of, i. 788
inflammations of, i. 778, 880
malformations of, i. 743
sarcoma of, i. 796
teratoma of, i. 795
tumors of, i. 784, 795
Neck, abscesses of, ii. 76
branchiogenic, ii. 123
actinomycosis of, ii. 86
aneurisms of, ii. 66
arterial, ii. 66
of common carotid, ii. 66
of external carotid, ii. 70
of innominate, ii. 70
of internal carotid, ii. 70
of subclavian above collar-bone, ii. 72
arteriovenous, ii. 73
of common carotid and internal jugular, ii. 73
Neck, aneurisms of, arteriovenous, of external carotid and internal jugular, ii. 75
extracranial, of internal carotid, ii. 75
of subclavian vessels, ii. 75
angioma of, ii. 130
arteries of, injuries of, ii. 40
ligation of, ii. 44
boils of, ii. 75
branchial clefts, outgrowth of skin of, ii. 23
carbuncles of, ii. 75
carcinoma of, primary, ii. 138
cysts of, blood-, ii. 126
branchiogenic, ii. 120
congenital serous, ii. 123
subcutaneous dermoid, ii. 126
enchondroma of, ii. 137
erysipelas of, ii. 76
fibroma of, ii. 132
fistula of, ii. 17
hæmangioma of, ii. 130
inflammations of, ii. 75
lipoma of, ii. 133
lymphangioma cavernosum of, ii. 131
lymph-glands of, diseases of, ii. 89
neoplasms of, ii. 109
secondary malignant involvement of, ii. 119
syphilis of, ii. 108
lymphosarcoma of, ii. 118
nerves of, injuries of, ii. 62
neuroma of, ii. 136
sarcoma of, primary, ii. 137
skin of, sebaceous cysts of, ii. 128
suppuration of, ii. 76
teratoma of, ii. 24
tuberculous abscesses of, ii. 85
tumors of, ii. 120
veins of, injuries of, ii. 55
ligation of, ii. 59
Necrosis of pancreas, iv. 719, 723
Nélaton's prepuce dilator, v. 629
splint for Colles' fractures, iii. 297
Neoplasms of axilla, iii. 83
of clavicle, iii. 85
of foot, iii. 870
of hand, iii. 365
of knee, iii. 646
of leg, iii. 709
of lymph-glands of neck, ii. 109
of scapula, iii. 80
in shoulder, soft parts of, iii. 84
of skin of upper arm, iii. 144
of thigh, iii. 555
Nephrectomy for calculi of kidney, v. 315
in suppurative nephritis, v. 291
in tuberculosis of kidney, v. 329
in tumors of kidney, v. 353
in uronephrosis, v. 282
Nephritis, suppurative, v. 283
Nephrolithiasis, v. 293
Nephropexy, v. 252
Nephrotomy in calculi of kidney, v. 399

Nephrotomy in hemorrhage of kidney, v. 343
in tuberculosis of kidney, v. 329
in uronephrosis, v. 276
Nerves, abducens, injuries of, i. 236
auditory, injuries of, i. 238
auricularis magnus, exposure of, i. 603
auriculotemporal, resection of, i. 577
cranial, paralysis of, in fracture of skull, i. 91
at elbow, diseases of, iii. 236
injuries of, iii. 236
-joint, location of, iii. 227
operations on, iii. 240
facial, injuries of, i. 237
of forearm, operations on, iii. 261
inferior dental, resection of, i. 576
maxillary, resection of, i. 575
lingual, resection of, i. 576
median, injuries of, iii. 237, 626
plastic operations on, iii. 240
in upper arm, exposure of, iii. 156
musculospiral, injuries of, iii. 124
paralysis of, iii. 133
in upper arm, exposure of, iii. 156
of neck, injuries of, ii. 62
occipital, exposure of, operation for, i. 599
minor, exposure of, i. 603
neuralgia of, i. 597
oculomotor, injuries of, i. 236
olfactory, injuries of, i. 235
ophthalmic, operation on, i. 573
optic, injuries of, i. 235
radial, injuries of, iii. 236
at elbow, iii. 236
plastic operations on, iii. 240
of shoulder, injuries of, iii. 23
superior maxillary, resection of, i. 574
of thigh, diseases of, iii. 551
stretching of, iii. 561
tumors of, iii. 558
trigeminal, injuries of, i. 237
second branch of, resection of, i. 577
third branch of, resection of, i. 579
trochlear, injuries of, i. 236
ulnar, injuries of, iii. 238
plastic operations on, iii. 239
in upper arm, diseases of, iii. 145
exposure of, iii. 156
injuries of, iii. 122
neuroma of, iii. 145
Nervous gastric spasm, iv. 315
Neuralgia, i. 561
of hip-joint, iii. 501
intercostal, ii. 460
of knee-joint, iii. 624
of mammary gland, ii. 576
Morton's, iii. 857
Neuralgia of occipital nerve, i. 597
renal, v. 344
trigeminal, i. 561
of venesection, iii. 127
Neurectomy of inferior maxillary, i. 575
of ophthalmic nerve, i. 573
of superior maxillary, i. 574
for trigeminal neuralgia, i. 570
Neuritis ascendens, i. 234, 238
brachial, iii. 145
descendens, i. 234
post-traumatic, of fingers, iii. 318
of hand, iii. 318
Neurofibromata of face, i. 502
Neurogenic contractions, ii. 37
Neuroma of chest-wall, ii. 465
of face, plexiform, i. 504
of hand, iii. 370
of neck, ii. 136
of nerves of upper arm, iii. 145
Neuromuscular scoliosis, ii. 799
Neuropathic affections of foot, ii. 867
of hip-joint, iii. 501
of knee-joint, iii. 624
arthritis of hand, iii. 250
omarthritis, iii. 96
Neurosis of larynx, ii. 223
of knee-joint, iii. 624
of shoulder-joint, iii. 102
Neurotomy for trigeminal neuralgia, i. 570
Nipple, diseases of, ii. 564
Nitze's bladder forceps with electric lamp, v. 534
operating cystoscope, v. 531
Nodes, syphilitic, of skull, i. 151
Noma, i. 819
Nose, clefts of, i. 419
enchondroma of, i. 784
examination of, methods of, i. 736
exposure of, preliminary operation for, i. 802
foreign bodies in, i. 755
fracture of, i. 745
glanders of, i. 776
granulomata of, i. 775
hæmatoma of septum of, i. 750
hemorrhage of, i. 750
inflammations of, i. 758
injuries of, i. 745
leprosy of, i. 776
lipoma of, i. 784
malformations of, i. 743
operations on, flap formations, i. 803
plastic, i. 531
osteoma of, i. 784
phlegmon of, i. 480
polypi of, i. 784
reflection of, operations for, i. 804
rhinoscleroma of, i. 776
saddle, Helferich's operation for, i. 553
septum of, hæmatoma of, i. 750
speculums, i. 739
splitting of, operations for, i. 803

Nose, syphilis of, i. 775
tuberculosis of, i. 774
tumors of, i. 784
ulcerations of, i. 773

OBLIQUE inguinal hernia, iv. 554
Obstruction of intestine, iv. 331
in peritonitis, iv. 170
Obturator hernia, iv. 605
Occipital artery, ligation of, in scalp-wounds, i. 35
convolutions, i. 258
nerve, exposure of, operations for, i. 599
minor, exposure of, i. 603
neuralgia of, i. 597
Occlusion of rectum combined with fistula, v. 90
complete without fistula, v. 87
Oculomotor nerve, injuries of, i. 237
Odontoma of jaw, i. 696
O'Dwyer's apparatus for intubation of larynx, ii. 186
Œdema of arm, malignant, iii. 143
of aryteno-epiglottic fold, i. 917
of glottis in phlegmonous glossitis, i. 839
of larynx, ii. 185
of scalp in newborn, i. 18
Œsophagitis, follicular, iv. 59
toxic, iv. 61
Œsophagomalacia, iv. 31
Œsophagoplastic, iv. 118
Œsophagoscopy, iv. 17
Œsophagostomy, iv. 81, 120
dorsal, iv. 52
internal, iv. 81
Œsophagus, actinomycosis of, iv. 64
atresia of, congenital, iv. 23
auscultation of, iv. 20
carcinoma of, iv. 111
catarrh of, iv. 59
cervical portion of, wounds and injuries of, iv. 26
cysts of, iv. 106
dilatation of, for strictures, iv. 88
diphtheria of, iv. 59
diverticulum of, iv. 94
ectasis of, iv. 92
examination of, iv. 17
fibroma of, iv. 106
fistula of, iv. 29
foreign bodies in, iv. 34
hemorrhage of, iv. 33
inflammations of, iv. 59
injuries of, iv. 26
lipoma of, iv. 106
malformations of, iv. 23
myoma of, iv. 106
papilloma of, iv. 106
percussion of, iv. 20
perforation of, iv. 32, 69, 75
phlegmon of, iv. 54, 60
polypus of, iv. 108
probing of, iv. 20
Œsophagus, radioscopy of, iv. 20
resection of, for carcinoma, iv. 118
for stricture, iv. 85, 118
rupture of, iv. 31
sarcoma of, iv. 107
stenosis of, low pressure, iv. 65
stricture of, iv. 65
syphilis of, iv. 63
thoracic portion of, wounds and injuries of, iv. 29
thrush of, iv. 59
tuberculosis of, iv. 63
ulcers of, iv. 62
varix of, iv. 108
Oeltingen's method for club-foot, iii. 816
Olecranon bursitis, iii. 144
Olfactory nerves, injuries of, i. 235
Ollier's posterior tarsectomy, iii. 886
resection of ankle-joint, iii. 882
of shoulder-joint, iii. 106
Omarthritis, iii. 89
deformans, iii. 95
fibrous, iii. 89
neuropathic, iii. 96
purulent, iii. 91
serous, iii. 89
tuberculous, iii. 92
Omentum, injuries of, iv. 273
torsion of, iv. 197
tumors of, iv. 196
Onychia, iii. 776
Onychogryphosis, iii. 775
Onyxis, iii. 776
Operations, abdominal, iv. 481
on air-passages, ii. 250
on arm, upper, iii. 156
on auditory canal, i. 407
blepharoplasty, i. 557
for carcinoma of tongue, i. 869
cheiloplasty, i. 543
cholecystectomy, iv. 684
cholecystenterostomy, iv. 686
cholecystostomy, iv. 681
choledochotomy, iv. 693
for cleft of bladder, v. 432
formations, i. 425, 439
palate, i. 449
colopexy, v. 142
colostomy, iv. 456
cryoscopy, v. 213
dorsal œsophagotomy, iv. 52
duodenostomy, iv. 455
on elbow and forearm, iii. 259
-joint, iii. 222
enteropexy, iv. 454
enteroplasty, iv. 454
enterorrhaphy, iv. 454
enterostomy, iv. 454
for intestinal obstruction, iv. 346
enterotomy, iv. 454
for intestinal obstruction, iv. 346
for exposure of auricularis magnus nerve, i. 603
of occipital nerves, i. 599, 603
for exstrophy of bladder, v. 431

Operations for extirpation of salivary glands, i. 655
on fingers, iii. 374
for fistula of ureter, v. 379
on foot and its joints, iii. 873
on forearm, nerves of, iii. 261
gastrectasia, iv. 314
gastrectomy, iv. 451
gastro-anastomosis, iv. 427
gastroduodenostomy, iv. 427
gastro-enterostomy, iv. 427
for carcinoma of stomach, iv. 382
for ulcer of stomach, iv. 312
gastrojejunostomy, iv. 428
gastrolysis, iv. 411
gastropexy, iv. 412
gastroplasty, iv. 427
gastroplication, iv. 409
gastrorrhaphy, iv. 412
gastrostomy, iv. 414, 416
for carcinoma of stomach, iv. 383
for foreign-bodies in œsophagus, iv. 50
for stricture of œsophagus, iv. 86
on hand, iii. 374
plastic, of tendons, iii. 375
for harelip, i. 425
on heart, ii. 553
for hemorrhoids, v. 132
for hernia of bladder, v. 468
herniotomy, iv. 535
at hip, iii. 524
ileostomy, iv. 456
on jaws, i. 719
jejunostomy, iv. 455
for carcinoma of stomach, iv. 383
for ulcer of stomach, iv. 310
laminectomy, ii. 642
laparotomy, iv. 201
laryngotomy, ii. 276
of leg, iii. 713
lithotomy, lateral perineal, for vesical calculi, v. 511
lithotrity for vesical calculi, v. 514
mastoid, i. 395
mediastinotomy, iv. 56
meloplasty, i. 552
nephrectomy, v. 394
nephropexy, v. 252
nephrotomy, v. 413
neurectomy, i. 551
neurotomy, i. 570
on nose, flap formation, i. 803
reflection of, i. 804
splitting of, i. 803
œsophagoplastic, iv. 118
œsophagoscopy, iv. 17
œsophagostomy, iv. 81, 120
œsophagotomy, dorsal, iv. 52
internal, iv. 81
on ophthalmic nerve, i. 573
on orbit for osteoma, i. 138
Operations on orbit for sarcoma, i. 517
on pelvis, v. 73
upon pericardial effusion, ii. 548
peripheral, for trigeminal neuralgia, i. 569
on pharynx, i. 915
for phimosis, v. 629
plastic, on cheek, i. 552
on eyelids, i. 556
on lips, i. 543
on median nerve, iii. 240
on mouth, i. 551
on nose, i. 531
on radial nerve, iii. 240
on tendons of hand, iii. 375
on ulnar nerve, iii. 239
in uronephosis, v. 277
for parotid fistula, i. 614
for pleural effusions, exploratory puncture in, ii. 488
preliminary, for exposure of nose, i. 802
for prolapse of rectum, v. 140
prostatectomy, for hypertrophy of prostate, v. 556
prostatotomy for hypertrophy of prostate, v. 556
pyelostomy, v. 415
pyloroplasty, iv. 423
radical, for cure of hernia, iv. 504
on middle ear, i. 401
rectopexy, v. 142
for reflection of nose, i. 804
for removal of eyeball, i. 730
of Gasserian ganglion, i. 585
rhinoplasty, i. 535
for rupture of bladder, v. 453
for saddle-nose, i. 531
for sarcoma of face, i. 517
on shoulder, iii. 104
on skull, methods of, i. 325
splenectomy, iv. 706
splenopexy, iv. 711
on stomach, iv. 409, 444
stomatoplasty, i. 551
suprapubic cystotomy, for hypertrophy of prostate, v. 555
for vesical calculi, v. 511
tarsectomy, iii. 885
on thigh, iii. 559
thyrotomy, ii. 277
tonsillotomy, i. 896
tracheotomy, ii. 250
urethrotomy, v. 597
external, v. 611
internal, v. 610
vasectomy, v. 560
on wrist, iii. 374
Optic nerve, injuries of, i. 235
thalamus, injuries of, i. 261
Orbit, exostosis of, i. 134
fractures of, i. 111, 112
Orchitis, acute, v. 697
chronic, v. 699
compressor, v. 699

Organic strictures of urethra, v. 599
Organotherapy in treatment of goitre, ii. 321
Ossification of biceps tendon, iii. 242
of muscles of upper arm, iii. 144
Osteoid tumors of femur, iii. 556
Osteoma of foot, iii. 870
of frontal sinus, i. 134
of hand, iii. 372
of jaw, i. 702
of lung, ii. 529
of mammary gland, ii. 581
of mastoid, i. 389
of neck, ii. 137
of nose, i. 784
of skull, i. 134
of testicle, v. 715
Osteomalacia, i. 131
Osteomyelitis, acute, of cranial bones, i. 161
of femur, iii. 551
of hip-joint, iii. 458
of leg, iii. 697
of pelvis, v. 45
of tibia, iii. 697
of vertebræ, ii. 697
of bones of forearm, iii. 255
complicating scalp-wounds, i. 32
of humerus, iii. 147
of jaw, i. 691
of metatarsals, iii. 784
of radius, iii. 255
of ribs, ii. 455
of sternum, ii. 455
of toes, iii. 784
of ulna, iii. 255
Osteophlebitis, i. 292
Osteoplastic resection of jaw, i. 725, 732
of skull, i. 328
Osteoporosis of skull, i. 131
Osteosarcoma of foot, iii. 871
Osteotabes infantum, i. 130
Ostitis deformans of skull, chronic, i. 131
of facial bones, acute suppurative, i. 488
of temporal bone, i. 373
Othæmatoma, i. 348
Otis' evacuator, v. 528
urethrometer, v. 604
Otitic cerebral abscess, i. 282
Otitis media, i. 364, 382

PALATE, cleft, i. 443
syphilis of, hereditary, i. 826
Panaritium, iii. 322
Pancreas, abscess of, iv. 724
annular, iv. 715
calculus of, iv. 726, 739
carcinoma of, iv. 737
cysts of, iv. 726
diseases of, iv. 719
displacement of, iv. 718
hemorrhage of, iv. 719
incision of, for biliary calculi, iv. 687
inflammation of, iv. 719
Pancreas, injuries of, iv. 717
lymph-cyst near, iv. 728
necrosis of, iv. 719, 723
relation of, to common duct, iv. 714
tumors of, iv. 737
ulcer of stomach invading, iv. 209
wounds of, gunshot, iv. 718
Pancreatic cysts, false, iv. 728
Pancreatitis, chronic, compared with carcinoma of gall-bladder, iv. 696
hemorrhagic, iv. 722
interstitial, chronic, iv. 725
suppurative, iv. 721
Papilloma of biliary passages, iv. 694
of bladder, benign, cystophotographs of, v. 528
multiple villous, v. 523
solitary, v. 523
in foot, iii. 871
of gall-bladder, iv. 694
of œsophagus, iv. 106
of penis, v. 644
of pharynx, i. 906
of rectum, v. 148
of tongue, i. 856
of urethra, v. 622
Paracentesis in operations for pleural effusions, ii. 488
Paralysis of forearm, tendon transplantation for, iii. 240
general, following cranial injuries, i. 315
of musculospiral nerve, iii. 133
pressure, of nerves of arm, iii. 124
Paralytic contracture of hip-joint, iii. 510
deformities of hip-joint, iii. 510
dislocation of hip-joint, iii. 510
loose hip-joint, iii. 510
Paranephritic cysts of kidney, v. 372
Paraphimosis, v. 639
Parietal convolutions, injuries of, i. 257
Paronychia, iii. 776
Parotid duct, fistula of, i. 612
injuries of, i. 609
fistula, i. 611
gland, extirpation of, i. 655
inflammations of, i. 624
injuries of, i. 608
Parotitis, epidemic, i. 626
Passow's method of restoration of auditory canal after radical operation, i. 407
Patella, dislocation of, congenital, iii. 589
downward, iii. 591
lateral, iii. 588
vertical, iii. 590
fracture of, iii. 573
refracture of, iii. 581
rider-pain of, iii. 565
Pawlik's ureteral catheterization, v. 196
Pearl-carvers' bones, i. 688
tumors, i. 382, 390
Pedunculus, i. 261
Pelvic organs, peritonitis from, iv. 181
Pelvirectal abscess, v. 110

Pelvis, arteries of, aneurism of, v. 59
ligation of, v. 73
bones of, fractures of, v. 23
syphilis of, v. 55
tuberculosis of, v. 50
congenital malformations of, v. 17
crushes of, v. 38
diseases of, v. 17
dislocations of, v. 38
echinococcus of, v. 71
floor of, hernia of, iv. 621
inflammatory infections of, v. 45
injuries of, v. 17
joints of, tuberculosis of, v. 50
of kidney, primary new growth of, v. 373
tumors of, v. 349
lipoma of, v. 20
lymphangioma of, v. 20
new growths of, v. 63
operations on, v. 73
renal, tumors of, v. 373
suppuration of, v. 55
teratoma of, v. 20
wounds of, v. 39
Pendulous abdomen, iv. 133
Penile hypospadias, v. 583
Penis, absence of, v. 625
amputation of, v. 651
angioma of, v. 645
carcinoma of, v. 646
cellulitis of, v. 640
congenital anomalies of, v. 625
constrictions of, v. 632
cysts of, v. 643
diseases of, exclusive of venereal disease, v. 637
dislocations of, v. 634
divided, v. 625
double, v. 625
elephantiasis of, v. 642
erysipelas of, v. 641
fracture of, v. 631
inflammations of, v. 637
injuries of, v. 631
papilloma of, v. 644
sarcoma of, v. 645
tuberculosis of, v. 643
tumors of, v. 643
warts of, v. 644
wounds of, v. 634
Peptic ulcer of œsophagus, iv. 64
Perforation of intestine, test for, iv. 156
of œsophagus, iv. 32, 69, 75
Periarthritis humeroscapularis, iii. 78
Pericardial effusions, operations upon, ii. 548
Pericarditis, purulent, ii. 548
Pericardium, incision into, ii. 551
injuries of, ii. 399
puncture of, ii. 549
surgical diseases of, ii. 548
Pericholecystitis from gall-stones, iv. 666
Perichondritis laryngea, ii. 200
Pericystitis, cystitis following, v. 483
Perineal hernia, iv 621
Perinephritic abscess, v. 336
tubercular, v. 320
Perinephritis, v. 333
Perineum, wounds of, v. 40
Periorchitis, acute serofibrinous, v. 670
serous, v. 670
adhesive, v. 684
chronic serous, v. 673
hemorrhagic, v. 682
proliferative, v. 684
purulent, v. 672
Periosteal cysts, i. 699
sarcoma of jaw, i. 704
Periostitis complicating otitis media, i. 370
of facial bones, acute suppurative, i. 481
of jaw, i. 689
post-traumatic, of fingers, iii. 320
of hand, iii. 320
Peripleuritic abscesses, ii. 454
Periproctal connective tissue, inflammations in, v. 106
Perispermatitis, acute serous, v. 672
chronic serous, v. 684
hemorrhagic, v. 685
Perithelioma of kidney, v. 358
Peritoneal clamp, iv. 209
Peritoneum, actinomycosis of, iv. 196
carcinoma of, iv. 196
diseases of, iv. 160
foreign bodies in, iv. 214
inflammation of, iv. 160
injuries of, iv. 156
pouches of, iv. 153
resorption of, iv. 154
teratoma of, iv. 198
transudation of, iv. 154
tumors of, iv. 196
wounds of, iv. 156
Peritonitis, acute circumscribed, iv. 181
from appendix, iv. 179, 353
aseptic, iv. 162
chronic adhesive, iv. 191
exudative, iv. 190
complicating laparotomy, iv. 228
diffuse, iv. 164
from duodenal ulcer, iv. 179
following subcutaneous injuries of abdomen, iv. 159
from gastric ulcer, iv. 179
muscular contraction in, iv. 170
obstruction of intestine in, iv. 170
from pelvic organs, iv. 181
post-operative, iv. 181
subphrenic abscess, iv. 184
tuberculous, iv. 192
from typhoid ulcers, iv. 180
from ulcers of intestine, iv. 319
of stomach, iv. 302
urinary infiltration causing, v. 452
Peritonsillitis, i. 886
Periureteritis, v. 390
Perobrachia, iii. 117

Perrin's incision, iii. 877
Pessary, dumb-bell, v. 131
Petit's operation for radical cure of hernia, iv. 536
Phalanges of fingers, amputation of, iii. 379
dislocation of, iii. 309
fracture of, iii. 308
resection of, iii. 384
sequestrotomy for, iii. 384
of foot, fractures of, iii. 768
of toes, dislocation of, iii. 770
Pharyngeal, retro-, abscess, i. 890
tonsil, hypertrophy of, i. 779
Pharyngitis, chronic, i. 893
Pharyngotomy, i. 915
Pharynx, abscess of, i. 890
adhesions of, i. 903
angioma of, i. 907
carcinoma of, i. 912
congenital cysts of, i. 877
dermoids of, i. 905
dilatation of, for atresia and stenosis, i. 904
diphtheria of, i. 886
diseases of, i. 880
diverticulum of, i. 877
fistula of, i. 877, 917
foreign bodies in, i. 879
glanders of, i. 902
injuries of, i. 879
leprosy of, i. 901
lipoma of, i. 909
lupus of, i. 899
lymphangioma of, i. 908
lymphosarcoma of, i. 911
malformation of, i. 877
operations on, i. 915
papilloma of, i. 906
polypi of, i. 905
racemose aneurism of, i. 908
retrovisceral struma of, i. 910
rhinoscleroma of, i. 902
sarcoma of, i. 912
stenosis of, i. 902
syphilis of, i. 898
teratoma of, i. 877
tuberculosis of, i. 898, 901
tumors of, i. 905
varix of, i. 908
Phimosis, acquired, v. 638
congenital, v. 626
operation for, v. 629
producing hydrocele, v. 628
nocturnal incontinence, v. 629
scissors, v. 629
Phlebitis of fingers, iii. 331
of hand, iii. 331
Phlegmon complicating salivary calculus, i. 621
of face, i. 480
of foot, iii. 773
of leg, iii. 684
of nose, i. 480
of œsophagus, iv. 54, 60
Phlegmon, retro-œsophageal, iv. 54
of scalp, i. 64
of upper lip, i. 480
Phlegmonous glossitis, i. 836
peritonsillitis, i. 886
processes in arm, iii. 143
in hand, iii. 321
Phocomelia, iii. 117
Phosphates, vesical calculi composed of, v. 502
Phosphorus necrosis of jaw, i. 681
Pial vessels, injuries of, i. 228
Pile-clamps, v. 133
Pinna, wounds of, i. 347
Pirogoff's amputation at ankle, iii. 873
Pleura, echinococcus of, ii. 500.
effusions of, ii. 473
isolated injuries of, ii. 378
tumors of, malignant, ii. 500
Pleuritis exudative serosa, ii. 478
Pneumatocele of head, i. 40
Pneumonia after choledochotomy, iv. 693
complicating laparotomy, iv. 230
inspiration in phlegmonous glossitis, i. 839
Pneumothorax after operations for empyema, ii. 493
Polycystic degeneration of kidney, v. 367
Polydactylia, iii. 272
Polypi, mucous, of rectum, v. 146
of nose, i. 784
of œsophagus, iv. 108
of pharynx, i. 905
of urethra, v. 622
Polypoid growths of accessory sinuses of nose, i. 784
of nose, i. 784
Polyposis recti, v. 147
Polyps, mucous, of rectum, v. 146
of urethra, v. 622
Polypus forceps, i. 786
Pons, lesions of, i. 261
Popliteal aneurism, iii. 654
bursa, hygroma of, iii. 652
cysts, iii. 652
space, abscess of, iii. 654
aneurism in, iii. 654
vessels, injuries of, iii. 570
Portal vein, obstruction of, iv. 330
Post-operative peritonitis, iv. 181
Post-traumatic neuritis of fingers, iii. 318
of hand, iii. 318
periostitis of fingers, iii. 320
of hand, iii. 320
Postural scoliosis, ii. 778
Pott's disease. ii. 701
fracture, iii. 733
Pouches of peritoneum, iv. 153
Pregnancy, hemorrhage in, v. 341
Prepatellar bursitis, iii. 650
Prepuce dilator, v. 629
Presenile gangrene of fingers, iii. 338
of hand, iii. 338

Pretibial bursitis, iii. 651
Prevesical space, pus in, iv. 131
Proctitis, simple, of rectum, v. 98
Proctoscope, Kelly's, v. 80
Simon's, v. 80
Tuttle's, v. 80
Proctotomy, v. 122
Prolapse of anus, v. 136
of bladder, v. 464
of rectum, v. 136, 147
of spleen, iv. 702
of testicle, v. 661
Prolapsus recti, v. 147
Proliferative periorchitis, v. 684
Prostate gland, anatomy of, v. 539
anomalies of, v. 541
calculi of, v. 561
carcinoma of, v. 563
cystitis due to, v. 497
cysts of, v. 564
diseases of, v. 539
examination of, v. 546
fibroma of, v. 562
function of, v. 541
hypertrophy of, v. 545
inflammations of, v. 542
injuries of, v. 542
sarcoma of, v. 562
stricture of, cystitis due to, v. 497
syphilis of, v. 545
tuberculosis of, v. 545
tumors of, v. 562
Prostatectomy in treatment of hypertrophy of prostate, v. 556
Prostatic calculi, v. 561
incisor, v. 557
Prostatitis, acute, v. 542
chronic, v. 543
Prostatotomy in treatment of hypertrophy of prostate, v. 556
Prothesis for upper arm, iii. 159
Pruritus ani, v. 97
Pseudarthrosis of humerus, iii. 134
of leg, iii. 682
Pseudocroup, ii. 199
Pseudo-erysipelas of hand, iii. 330
Pudic artery, internal, ligation of, v. 75
Puerperal mastitis, ii. 567
Purulent omarthritis, iii. 91
periorchitis, v. 672
Putrid empyema, ii. 484
Pyelitis, v. 283
Pyelostomy, v. 415
Pyemia, abscess of liver from, iv. 639
Pyloric obstruction, acute, iv. 294
Pyloroplasty, iv. 423
Pylorus, divulsion of, iv. 409
elimination of, iv. 453
for carcinoma of stomach, iv. 383
stenosis of, iv. 290
Pyonephrosis, v. 283
Pyothorax, ii. 480

QUADRICEPS tendon, rupture of, iii. 581

RACEMOSE aneurism of pharynx, i. 908
Radial artery, ligation of, iii. 259
at wrist, iii. 375
nerve, injuries of, iii. 236
at elbow, iii. 236
plastic operations on, iii. 91
Radioscopy of œsophagus, iv. 20
Radius, defect of, iii. 243
diseases of, iii. 255
dislocation of, congenital, iii. 164
head of, iii. 207
lower end of, iii. 303
fracture of head of, iii. 194
of lower end of, iii. 286
of neck of, iii. 195
of shaft of, iii. 253
malformations of, iii. 243
osteomyelitis of, iii. 255
sarcoma of, iii. 257
subluxation of head of, iii. 195
tumors of, iii. 257
and ulna, shaft of, fracture of, iii. 247
"Rankenangiom" of Virchow, i. 49
Ranula, i. 848
Raynaud's gangrene of foot, iii. 865
Rectal bougies, Créde's, v. 121
specula, Weiss', v. 81
Rectocolonic speculum, Bodenhammer's, v. 79
Rectum, adenoids of, v. 146
anatomy of, v. 77
atresia of, v. 83
carcinoma of, v. 148
chancroids of, v. 141
congenital fistula of, v. 86
malformations of, v. 83
dilating bougies for, v. 122
diseases of, v. 97
examination of, v. 78
foreign bodies in, v. 94
hemorrhage from, v. 92
inflammations of, v. 97
gonorrhœal, v. 99
injuries of, v. 92
irrigation of, in proctitis, v. 99
mucous polyps of, v. 146
occlusion of, combined with fistula, v. 90
complete, without fistula, v. 87
papilloma of, v. 148
proctitis of, simple, v. 98
prolapse of, v. 136
resection of, v. 147
simple proctitis of, v. 99
stricture of, v. 118
suppuration about, v. 106
syphilitic affections of, v. 101
tuberculosis of, v. 103
tumors of, v. 144
benign, developing from connective tissue, v. 145

Rectum, tumors of, benign, developing from epithelial portion of rectum, v. 146
malignant epithelial growths, v. 148
ulcers of, v. 98
gonorrhœal, v. 99
ureters transplanted in, v. 443
used as bladder, v. 442
Rectus muscle, inflammation in sheath of, v. 130
Reflection of nose, operation for, i. 804
Refracture of patella, iii. 581
Removal of spleen, iv. 706
Renal arteries, aneurisms of, v. 373
colic, v. 346
hæmophilia, v. 342
hemorrhage, v. 329
essential, v. 340
neuralgia, v. 344
pelvis, tumors of, v. 373
Repair of jaw, artificial, after resection, i. 720
Resection of ankle-joint, iii. 880
of astragalus, iii. 885
of auriculotemporal nerve, i. 577
of bladder, for tumors, v. 534
of calcaneum, iii. 784
of carpus, iii. 380
of clavicle, iii. 110
of elbow-joint, iii. 222
of hip-joint, iii. 524
of humerus, iii. 157
of inferior dental nerve, i. 576
of intestine, iv. 468
of jaw, i. 719, 725
osteoplastic, i. 725, 732
of joints of toes, iii. 887
of kidney, v. 410
of lingual nerve, i. 576
of maxillary nerve, inferior, i. 576
superior, i. 574
of metacarpals, iii. 384
of metatarsals, iii. 887
of œsophagus, for carcinoma, iv. 118.
for stricture, iv. 85, 118
of phalanges of fingers, iii. 384
of rectum, v. 141
of scapula, iii. 111
of scrotum, for varicocele, v. 691
of shaft of upper arm, iii. 157
of shoulder-joint, iii. 106
of skull, i. 326
osteoplastic, i. 328
of stomach, iv. 444
for carcinoma, iv. 381
tibiocalcaneal, of Bruns, iii. 886
of tibiotarsal joint, iii. 880
of ureter, v. 383
Wladimiroff-Mikulicz' osteoplastic, iii. 886
of wrist-joint, iii. 579
Resorption of peritoneum, iv. 154
Respiration, changes in, in cerebral hemorrhage, i. 214
Retention tumors of kidney, v. 258
Retromaxillary tumors, i. 712
Retro-œsophageal phlegmon, iv. 54
Retropharyngeal abscess, i. 890
tumors, i. 793, 911
Retrovisceral struma of pharynx, i. 910
Reverdin's method of suture of intestine, iv. 401
Rhachischisis, ii. 661
Rhachitic changes at base of skull, i. 128
coxa vera, iii. 518
curvatures of leg, iii. 706
of thigh, iii. 530
scoliosis, ii. 777
Rhachitis, congenital, i. 130
in fœtal life, i. 129
of skull, i. 127
Rheumatic coxitis, iii. 455
Rheumatism, articular, of metatarsals, iii. 784
of toes, iii. 784
chronic, of foot, iii. 784
of knee-joint, iii. 618
gonorrhœal, of metatarsals, iii. 784
of toes, iii. 784
Rhinitis, atrophic, i. 759
hypertrophic, i. 758
Rhinoliths, i. 755
Rhinoplasty, complete, i. 535
French method, i. 536
Hacker's method, i. 539
incomplete, i. 540
Italian method, i. 540
Rotter and Schimmelbusch's method, i. 537
Rhinoscleroma, i. 776
of pharynx, i. 902
Ribs, cervical, ii. 24
congenital malformations of, ii. 449
dislocation of, ii. 444
fractures of, ii. 428
osteomyelitis of, ii. 455
syphilis of, ii. 458
tuberculosis of, ii. 456
Rice-body hygroma of subdeltoid bursa, iii. 79
Rider's bone, iii. 550
pain of patella, iii. 565
Riedel's method for forward dislocation of shoulder, iii. 68
Ring fracture of skull, i. 77
Roloff's method for forward dislocation of shoulder, iii. 69
Roser's splint for Colles' fracture, iii. 297
Rotler's operation for radical cure of hernia, iv. 509
Rouge's operation for splitting of nose, i. 803
Roux' method of gastro-enterostomy, iv. 441
operation for exstrophy of bladder, v. 431
Rupprecht's catheter sterilizer, v. 486
Rupture of biceps, iii. 119
of bile-ducts, iv. 637

Rupture of bladder, v. 447
of deltoid, iii. 19
of gall-bladder, iv. 636
of ligamentum patellæ, iii. 581
of liver, iv. 633
of muscles of thigh, iii. 533
of upper arm, iii. 119
of œsophagus, iv. 31
of quadriceps tendon, iii. 581
of spleen, iv. 700
of stomach, spontaneous, iv. 275
of urethra, v. 589

SACROCOCCYGEAL meningocele, v. 17
tumors, v. 20
Sacrolumbar hypertrichoses and spina bifida occulata, v. 20
meningocele, v. 17
tumors, v. 20
Sacrum, dislocations of, with involvement of both sacro-iliac joints, v. 38
fractures of, v. 27
tumors of, v. 20
congenital, v. 17
Saddle-nose, i. 497
operations for, i. 531
Salivary calculi, i. 619
ducts, cysts of, i. 639
fistula of, i. 612
foreign bodies in, i. 618
inflammations of, i. 625
fistula, i. 611
glands, i. 607
actinomycosis of, i. 633
adenoma of, i. 650
angioma of, i. 643
anomalies of, i. 607
carcinoma of, i. 651
cysts of, i. 641
diseases of, i. 611
echinococcus of, i. 642
extirpation of, i. 645
fibroma of, i. 644
fistula of, i. 611
foreign bodies in, i. 618
inflammations of, i. 624, 631
injuries of, i. 608
lipoma of, i. 643
lymphangioma of, i. 643
myxoma of, i. 644
sarcoma of, i. 644
syphilis of, i. 635
tuberculosis of, i. 633
tumors of, i. 643
Sampson's toe-post, iii. 584
Saphenous vein, ligation of, iii. 694
Sarcoma of abdominal wall, iv. 133
of biliary passages, iv. 694
of bladder, v. 524
of chest-wall, ii. 469
of dura mater, i. 146
of ear, i. 393
of face, i. 515
of femur, iii. 556
Sarcoma of foot, iii. 871
of gall-bladder, iv. 694
of gums, i. 694
of hand, iii. 372
of humerus, iii. 151
of intestine, iv. 389
of jaws, i. 703
of kidney, v. 358
of larynx, ii. 233
of liver, iv. 657
of lung, ii. 526
of mammary gland, ii. 581
of nasopharynx, i. 796
of neck, primary, ii. 137
of œsophagus, iv. 107
of penis, v. 645
of pharynx, i. 912
of prostate gland, v. 562
of radius, iii. 257
of salivary glands, i. 644
of scalp, i. 53
of scrotum, v. 666
of skull, i. 142
of spermatic cord, v. 687
of stomach, iv. 369
of testicle, v. 687, 713
of thyroid gland, ii. 347
of tongue, i. 859
of tunica vaginalis, v. 687
of ulna, iii. 257
of umbilicus, iv. 148
Sarcomatous warts of scalp, i. 54
Saw, nasal, i. 753
Sayre's splint, iii. 31
Scalp, aneurisms of, i. 52
angioma of, i. 45
cavernous, i. 47
racemose arterial, i. 49
carcinoma of, i. 60
contusions of, i. 27
cysts of, dermoid, i. 58
sebaceous, i. 55
echinococcus of, in newborn, i. 18
erysipelas of, i. 62
erythema of, in newborn, i. 18
excoriations of, in newborn, i. 18
extravasations of, in newborn, i. 18
hæmatoma of, i. 28
inflammations of, i. 62
injuries of, i. 26
lipoma of, i. 42
œdema of, in newborn, i. 18
phlegmons of, i. 64
pressure-marks on, i. 18
sarcoma of, i. 53
wounds of, i. 26
Scapula, congenital elevation of, iii. 17
diseases of, iii. 86
fractures of, iii. 41
acromion and spine of, iii. 44
angles of, iii. 42
body of, iii. 42
coracoid process of, iii. 45
glenoid portion of, iii. 43
gunshot, iii. 45

Scapula, fractures of surgical neck of, iii. 43
neoplasms of, iii. 80
resection of, iii. 111
tumors of, iii. 86
Scarpa's splint for club-foot, iii. 815
Scars, abdominal, hernia in, iv. 614
Schede's operation for pleural effusion, ii. 494
for radical cure of hernia, iv. 516
splint for Colles' fracture, iii. 298
Schinzinger's method for forward dislocation of shoulder, iii. 66
Schrötter's plug for stenosis of larynx, ii. 215
Schüssler's apparatus for loose shoulder, iii. 601
Sciatic hernia, iv. 620
nerve, open stretching of, iii. 561
Sciatica of thigh, iii. 551
Scirrhous carcinoma of mammary gland, ii. 587
Scleroma of larynx, ii. 210
Scoliosis, ii. 775
congenital, ii. 776
neuromuscular, ii. 799
postural, ii. 778
rhachitic, ii. 777
static, ii. 777
Scoliosometer, ii. 788
Scrofulous lymphoma, ii. 93
Scrotal hernia, iv. 556
hypospadias, v. 584
Scrotum, carcinoma of, v. 666
congenital anomalies of, v. 653
cysts of, v. 666
dermoid, v. 666
sebaceous, v. 666
diseases of, v. 661
elephantiasis of, v. 663
erysipelas of, v. 662
gangrene of, v. 662
inflammation of, v. 661
injuries of, v. 660
lipoma of, v. 666
resection of, for varicocele, v. 691
sarcoma of, v. 666
tumors of, v. 663
benign, v. 666
malignant, v. 666
wounds of, v. 661
Scudder's dressing for fractured clavicle, ii. 30
humerus, iii. 57
Sebaceous cysts of ear, i. 390
of face, i. 519
of hand, iii. 309
of scalp, i. 55
of scrotum, v. 666
of skin of neck, ii. 128
of umbilicus, iv. 149
glands, adenoma of, i. 522
Segond's operation for exstrophy of bladder, v. 433
Seminal vesicles, calculi of, v. 719
diseases of, v. 718
excision of, v. 720
inflammation of, v. 719
tuberculosis of, v. 719
tumors of, v. 720
Senile atrophy of bones of skull, i. 132
gangrene of fingers, iii. 338
of hand, iii. 338
Sensation, unilateral disturbance of, in cerebral hemorrhage, i. 215
Sensory disturbances of foot, iii. 869
Septum of nose, abscess of, i. 750
cartilaginous deflection of, i. 751
deviation of, i. 752
deviation of, i. 751
hæmatoma of, i. 750
spurs of, i. 751
Sequestrotomy of metacarpals, iii. 384
of phalanges, iii. 384
Sequestrum, removal of, in syphilis of cranial bones, i. 157
Serofibrinous periorchitis, acute, v. 670
Serothorax, ii. 478
Serous cysts, congenital, of neck, ii. 123
periorchitis, chronic, v. 673
perispermatitis, acute, v. 672
chronic, v. 685
Sharp's amputation through metatarsals, iii. 879
Sheath of rectus muscle, inflammation in, iv. 130
Shoe, correct shape of, iii. 842
for flat-foot, iii. 842
plates, iii. 843, 844
Shoulder, amputation at, iii. 108
intrascapulothoracic, iii. 112
bursæ of, diseases of, iii. 78
congenital elevation of, iii. 17
dislocations of, iii. 60
backward, iii. 71
infraspinate, iii. 71
subacromial, iii. 72
congenital, iii. 18
deltoid paralysis following, iii. 70
forward, iii. 61
axillary, iii. 61
subcoracoid, iii. 61
habitual, iii. 76
old, iii. 73
-joint, ankylosis of, iii. 89
contracture of, iii. 99
contusions of, iii. 44
diseases of, iii. 89
hysterical, iii. 102
loose, iii. 100
neuroses of, iii. 102
resection of, iii. 106
sprains of, iii. 44
tuberculosis of, iii. 92
wounds of, iii. 46
muscles of, injuries of, iii. 19
nerves of, injuries of, iii. 23
operations on, iii. 104

Shoulder, skin of, injuries of, iii. 19
soft parts of, neoplasms of, iii. 84
tumors of, iii. 84
vessels of, injuries of, iii. 20
Sialo-adenitis acuta, i. 626
Sialodochitis, i. 625
Sialolithiasis, i. 619
Side-to-side anastomosis, iv. 472
Sigmoid volvulus of intestine, iv. 341
Simon-Küster's operation for effusion into pleura, ii. 494
Simon's hard-rubber urethral speculum, v. 195
incision in lumbar nephrectomy, v. 394
proctoscope, v. 80
urethral catheterization, v. 196
specula, v. 426
Sinus, cavernous, thrombus of, i. 479
frontal, empyema of, i. 768
infection complicating otitis media, i. 376
maxillary, empyema of, i. 765
pericranii, i. 53, 227
thrombosis, i. 295
Sinuses, accessory, of nose, empyema of, i. 765
inflammations of, i. 759
polypoid growths of, i. 784
of dura mater, injuries of, i. 224
Skin at elbow, diseases of, iii. 229
-graft, Thiersch's, after dissection of fibroma of scalp, i. 44
in lacerated wounds of scalp, i. 31
of shoulder, injuries of, iii. 19
of thigh, tumors of, iii. 557
of upper arm, neoplasms of, iii. 144
tumors of, iii. 144
Skull, defects of, in newborn, i. 25
deformities of, in newborn, i. 21
diseases of bones of, i. 127
drilling of, i. 325
echinococcus of, in newborn, i. 141
foreign bodies in, removal of, from punctured wounds, i. 112
fractures of, i. 65
injuries of bones of, i. 65
leontiasis of, i. 139
operations on, methods of, i. 325
osteoma of, i. 134
osteomyelitis of, acute, i. 161
resection of, i. 326
rhachitis of, i. 127
rupture of articulations of, during labor, i. 24
sarcoma of, i. 142
senile atrophy of, i. 132
soft parts of, injuries of, i. 26
tumors of, i. 40
syphilis of, i. 150
tuberculosis of, i. 158
tumors of, i. 134
wounds of, i. 197
Snapping finger, iii. 363
Snapping knee, iii. 633
Solitary papilloma of bladder, v. 523
Spasm, nervous gastric, iv. 315
Spastic stricture of œsophagus, iv. 73
of urethra, v. 599
Specula, rectal, Weiss', v. 81
Speculum, nasal, i. 739
rectocolonic, Bodenhammer's, v. 79
urethral, v. 195
Speech region, i. 259
Spermatic cord, diseases of, v. 668
fibroma of, v. 687
hæmatocele of, acute, v. 682
chronic, v. 685
hæmatoma of, v. 668
hydrocele of, acute, v. 672
bilocular, v. 676
chronic, v. 673
congenital, v. 676
diffuse, v. 686
multilocular, v. 686
lipoma of, v. 687
membranes of, inflammations of, acute, v. 670
chronic, v. 673
injuries of, v. 668
tumors of, v. 687
sarcoma of, v. 687
Spermatocele, v. 708
due to torsion of vas deferens, v. 712
intravaginal, v. 711
multilocular, v. 709
Sphincter, formed artificially, iv. 462
Sphincterotomy, posterior, v. 82
Spina bifida, ii. 652; v. 20
ventosa of fingers, iii. 353
Spinal accessory nerve, injuries of, ii. 65
cord, compression of, in caries of vertebræ, ii. 632
destruction of, ii. 628
hæmatomyelia of, ii. 630
stab-wounds of, ii. 629
treatment of injuries and diseases of, ii. 638
Spine, actinomycosis of, ii. 755
curvatures of, ii. 767
diseases of, ii. 797
myelomata of, ii. 765
spondylarthritis of, ii. 725
syphilis of, ii. 753
tibial, tear fracture of, iii. 582
tuberculosis of, ii. 701
tumors of, ii. 761
wounds of, ii. 694
Spinous processes of vertebræ, isolated fractures of, ii. 683
Spleen, abscess of, iv. 703
contusions of, iv. 700
cysts of, iv. 704, 706
echinococcus of, iv. 705
hypertrophy of, iv. 708
injuries of, iv. 700
in leukæmia, iv. 708
malarial enlargement of, iv. 700

Spleen, movable, iv. 710
prolapse of, iv. 702
removal of, iv. 706
rupture of, iv. 700
traumatism of, iv. 700
tumors of, iv. 704
Splenectomy, iv. 706
Splenopexy, iv. 711
Splint, Bruns', for leg and thigh, iii. 541
Buck's extension, iii. 545
extension, for femur, iii. 540
Helferich's extension, for femur, iii. 541
Hessing's, for thigh, iii. 542
Hodgen's suspension, iii. 545
Schede's suspension, for thigh, iii. 542
Volkmann's, iii. 540
Spondylarthritis, ii. 725
Spondylitis deformans, ii. 757
traumatic, ii. 679
tuberculosa, ii. 701
Sporadic cretinism, ii. 335
Sprains of ankle-joint, iii. 728
of elbow-joint, iii. 166
of knee, iii. 565
of shoulder-joint, iii. 44
of wrist, iii. 279
Sprengel's deformity, iii. 17
Spurs of nasal septum, i. 751
Staphylococcic empyema, ii. 484
Staphylococcus albus and citreus, i. 270
in scalp-wounds, i. 34
pyogenes albus, i. 251, 479
aureus, i. 250, 270
in face, i. 499
in mouth, i. 811
in osteomyelitis, i. 161
in tonsillitis, i. 880
Static deformities of knee, iii. 634
scoliosis, ii. 777
Steno's duct, i. 609
calculi of, i. 619
fistula of, i. 611
Stenosis, congenital, of intestine, iv. 251
of intestine from carcinoma, iv. 391
chronic, iv. 295
tuberculous, iv. 323
from ulcers, iv. 320
of larynx, ii. 211
of œsophagus, low-pressure, iv. 65
of pharynx, i. 902
of pylorus, iv. 290
of stomach from carcinoma, iv. 378
of trachea, ii. 218
Sternomastoid, diseases of, ii. 26
ligation of common carotid between heads of, ii. 44
syphilis of, ii. 38
Sternum, congenital fissure of, ii. 447
malformations of, ii. 446
fractures of, ii. 421
osteomyelitis of, ii. 455
syphilis of, ii. 458
Sternum, tuberculosis of, ii. 456
Stimson's fenestrated splint for leg, iii. 679
method for dislocated clavicle, iii. 39
for forward dislocation of shoulder, iii. 68
splint for Colles' fracture, iii. 299
for fractures of humerus, iii. 174
for Pott's fracture, iii. 740
Stomach, abscess of, iv. 315
adenoma of, iv. 369
cellulitis of, iv. 315
carcinoma of, iv. 370
congenital anomalies of, iv. 249
effects of stenosis of pylorus on, iv. 291
electric illumination of, iv. 238
escape of fluid from, iv. 258
examination of, iv. 233
excision of, iv. 444
extirpation of, iv. 444, 451
fistula of, iv. 281
foreign bodies in, iv. 276
hair-bulbs in, iv. 276
hemorrhage from following laparotomy, iv. 226
inflammatory disorders of, iv. 276
injuries of, iv. 254
nervous spasm of, iv. 315
operations on, iv. 409
removal of, for carcinoma, iv. 381
resection of, iv. 444
for carcinoma, iv. 381
traumatic perforation of, iv. 255
-tube, use of, iv. 237
tumors of, iv. 369
ulcers of, iv. 300
wounds of, iv. 263
Stomatitis, gangrenous, i. 819
ulcerative, i. 817
Stomatoplasty, i. 551
Stone-searcher, Guyon's, v. 422
Thompson's, v. 422
Stoppany's artificial jaw, i. 724
Storp's suspension cuff, iii. 298
Strangulated hernia, iv. 521
Strangulation of femoral hernia, iv. 521
of intestine due to Meckel's diverticulum, iv. 250
Streptococcic empyema, ii. 484
Streptococcus erysipelatis, i. 62
pyogenes, i. 250
in meningitis, i. 270
Stretching of nerves of thigh, iii. 561
Stricture of anus, v. 117
of œsophagus, iv. 65
of prostate, cystitis due to, v. 497
of rectum proper, v. 118
of urethra, v. 599
congenital, v. 571
Struma of accessory thyroid, i. 910
retrovisceral, of pharynx, i. 910
Subastragaloid amputation, iii. 876
dislocation, iii. 758

Subclavian artery, arterial aneurism of, 72
arteriovenous aneurisms of, ii. 75
injuries of, ii. 43; iii. 20
ligation of, ii. 53; iii. 20
veins, ligation of, ii. 60; iii. 104
Subcoracoid dislocation of shoulder, iii. 61
Subdeltoid bursitis, iii. 521
Subdural hemorrhage, i. 228
Subluxation of head of radius, iii. 195
of knee, habitual, iii. 587
Submaxillary region, actinomycosis of, i. 492
salivary gland, extirpation of, i. 656
suppuration, ii. 81
Submental inflammation, ii. 83
Subphrenic abscess, iv. 184
echinococcus of liver, iv. 649
Subungual growths in foot, iii. 870
Supernumerary digits, iii. 272
toes, iii. 722
Suppuration of bones of tarsus, iii. 783
of Cowper's glands, v. 624
of elbow-joints, iii. 211
of joints of tarsus, iii. 783
of neck, ii. 76
submaxillary, ii. 81
of tendon-sheaths of fingers, iii. 323
Suppurative cystitis, v. 481
dilatations of kidney, v. 283
inflammation of inguinal glands, iii. 522
of kidney, v. 283
of rectum, v. 106
nephritis, v. 283
pancreatitis, iv. 721
pyelitis, v. 287
Supraclavicular fossa, abscesses of, ii. 84
Supracondyloid fracture of humerus, iii. 169
Supramalleolar fractures, iii. 731
Suprapubic cystotomy for treatment of hypertrophy of prostate, v. 555
of vesical calculi, v. 511
Suprarenal gland, diseases of, v. 417
functions of, v. 416
tuberculosis of, v. 417
tumors of, v. 417
Sweat-gland, adenoma of, i. 522
Sylvius, fissure of, i. 259
Syme's amputation at ankle, iii. 873
Synovial sacs at elbow, diseases of, iii. 233
injuries of, iii. 233
Synovitis of ankle-joint, acute, iii. 781
of knee-joint, iii. 594
Syphilis of bones of leg, iii. 705
of breast, ii. 575
of clavicle, iii. 85
of cranial bones, i. 150
of ear, i. 386
of elbow-joint, iii. 211
of face, i. 495
of fingers, iii. 329
of foot, iii. 774
of hand, iii. 331
Syphilis of hand, hereditary, iii. 349
of humerus, iii. 149
of jaw, i. 679
of kidney, v. 347
of knee-joint, iii. 617
of larynx, ii. 207
of lymph-glands of neck, ii. 108
of mediastinum, ii. 540
of mouth, i. 823
of nose, i. 775
of œsophagus, iv. 63
of pelvic bones, v. 55
of pharynx, i. 898
of prostate, v. 545
of ribs, ii. 458
of salivary glands, i. 635
of skull, i. 154
of spine, ii. 753
of sternomastoid, ii. 38
of sternum, ii. 458
of testicle, v. 705
of thyroid gland, ii. 346
of tibia, iii. 705
of tongue, i. 824
of trachea, ii. 207
Syphilitic affections of anus, v. 101
of fingers, iii. 336
of hand, iii. 336
of rectum, v. 101
of skeletal foot, iii. 785
coxitis, iii. 455
cubital adenitis, iii. 143
hyperostosis of cranial bones, i. 155
inflammation of inguinal gland, iii. 522
myositis of upper arm, iii. 144
necrosis of cranial bones, i. 154, 155
periostosis, i. 150, 151
tenosynovitis of fingers, iii. 345
of hand, iii. 345
Syphiloma of liver, iv. 654
Syringomyelia in fingers, effects of, iii. 337
in hand, effects of, iii. 337
of knee-joint, iii. 625
Szymanowski's towel dressing, iii. 30

TABES, inflammations of jaw in, i. 688
Tabetic diseases of ankle-joint, iii. 869
of hip-joint, iii. 501
of knee-joint, iii. 625
of tarsus, iii. 869
Talipes calcaneus, iii. 846
cavus, iii. 850
equinus, iii. 824
valgus, iii. 829
varus, iii. 800
Talma's operation, iv. 660
Tarsal bones, dislocations of, iii. 758
small, fractures of, iii. 750
Tarsectomy, iii. 885
for club-foot, iii. 821
Tarsus, bones of, suppuration of, iii. 783
fractures of, iii. 744

Tarsus, joints of, suppuration of, iii. 783
tabetic disease of, iii. 869
Taxis, iv. 531
Taylor's phimosis scissors, v. 629
Tear fracture of spine of tibia, iii. 582
Teeth, tumors of, i. 696
Tegmentum, lesions of, i. 261
Telangiectasis of chest-wall, ii. 465
of foot, iii. 870
of hand, iii. 367
of scalp, i. 45
Temporomaxillary articulation, diseases of, i. 715
Tendo Achillis, subcutaneous division of, iii. 821
Tendon-sheaths of fingers, blood extravasation in, iii. 342
diseases of, iii. 342
gonorrhœa of, iii. 343
panaritium of, iii. 323
suppuration of, iii. 323
syphilis of, iii. 343
tenosynovitis of, acute serous, iii. 342
tuberculosis of, iii. 343
of foot, diseases of, iii. 778
of hand, blood extravasation in, iii. 342
diseases of, iii. 342
syphilis of, iii. 343
tenosynovitis of, acute serous, iii. 342
tuberculosis of, iii. 343
Tendons of elbow, diseases of, iii. 233
injuries of, iii. 233
of foot, dislocations of, iii. 729
injuries of, iii. 729
lacerations of, iii. 730
transplantation of, iii. 798
of forearm, diseases of, iii. 233
injuries of, iii. 233
transplantation in foot, iii. 778
for paralysis of forearm, iii. 240
for talipes calcaneus, iii. 849
at wrist, iii. 375
Tenesmus due to calculi of bladder, v. 506
Tenosynovitis of fingers, iii. 343
of hand, iii. 343
Teratoma associated with meningoceles, v. 20
of kidney, cystic, v. 372
of nasopharynx, i. 795
of neck, ii. 24
of pelvis, v. 20
of peritoneum, iv. 198
of pharynx, i. 877
of testicle, v. 716
Terner's method of establishing gastric fistula, iv. 420
Testicle, actinomycosis of, v. 707
adenoma of, v. 716
carcinoma of, v. 715
contusions of, v. 693
coverings of, diseases of, v. 668
cysts of, v. 707
Testicle, cysts of, dermoid, v. 716
diseases of, v. 693
dislocation of, v. 673
enchondroma of, v. 714
fibroma of, v. 687
hæmatoma of, v. 668
inflammations of, acute, v. 694
injuries of, v. 693
leprosy of, v. 707
lipoma of, v. 687
membranes of, tumors of, v. 687
osteoma of, v. 715
prolapse of, v. 661
sarcoma of, v. 687, 713
syphilis of, v. 795
teratoma of, v. 716
tuberculosis of, v. 699
tumors of, benign, connective tissue, v. 714
epithelial, v. 715
solid, v. 712
undescended, v. 653
wounds of, v. 694
Tetanus of head, i. 500
Tête carrée, in rhachitis, i. 127
Textor's amputation, iii. 877
T-fractures of condyles of humerus, iii. 177
Thiersch's method of neurectomy for trigeminal neuralgia, i. 571
operation for epispadias, v. 578
skin-grafts in wounds of scalp, i. 39
Thigh, amputation of, iii. 562
aneurism of, iii. 549
bones of, diseases of, iii. 551
injuries of, iii. 535
tumors of, iii. 555
carcinoma of, iii. 557
chondrofibroma, cystic, of, iii. 555
chondroma of, iii. 556
curvatures of, iii. 530
deformities of, iii. 530
diseases of, iii. 549
echinococcus of, iii. 557
enchondroma of, iii. 555
fibroma of, iii. 556
Höftmann's prothesis for, iii. 564
inflammatory processes of, iii. 551
lipoma of, iii. 556
lymphangiectasis of, iii. 550
lymphatics of, diseases of, iii. 550
muscles of, diseases of, iii. 550
hernia of, iii. 534
injuries of, iii. 533
rupture of, iii. 533
tumors of, iii. 557
myxoma of, iii. 556
neoplasm of, iii. 555
nerves of, diseases of, iii. 551
stretching of, iii. 561
tumors of, iii. 558
operations on, iii. 559
osteomyelitis of, acute, iii. 551
rider's bone of, iii. 550
sarcoma of, iii. 556

Thigh, sciatica of, iii. 551
skin of, tumors of, iii. 557
soft parts of, atheroma of, iii. 557
carcinoma of, iii. 557
cysts of, dermoid, iii. 557
lymph, iii. 557
diseases of, iii. 549
echinococcus of, iii. 557
elephantiasis nervorum of Bruns, iii. 558
enchondroma of, iii. 557
fibrolipoma of, iii. 557
fibroma of, iii. 557
hæmangioma of, iii. 557
hydroma of, iii. 557
leukæmic lymphoma of, iii. 558
lipoma of, iii. 557
lymphangioma of, iii. 557
lymphosarcoma of, iii. 557
myxoma of, iii. 557
neoplasms of, iii. 557
neurofibroma of, iii. 558
osteoma of, iii. 557
sarcoma of, iii. 557
tuberculous lymphoma of, iii. 557
tumors of, iii. 557
transplantation of tendons of, iii. 561
tumors of, iii. 555
varicose veins of, iii. 550
vessels of, diseases of, iii. 549
injuries of, iii. 532
ligation of, iii. 559
wounds of, gunshot, iii. 546
Thompson's catheter for hypertrophy of prostate, v. 551
forceps for removing vesical growths, v. 533
stone-searcher, v. 422
urethrotome, v. 611
Thoracic aorta, aneurisms of, ii. 541
duct, injuries of, ii. 61, 418
muscles, congenital malformations of, ii. 450
wall, actinomycosis of, ii. 458
Thoracotomy in operations for pleural effusions, ii. 490
Thorax, inflammations of, ii. 453
injuries of, ii. 367
malformations of, ii. 446
Thrombophlebitis, i. 292, 479
Thrombosis complicating laparotomy, iv. 231
of intracranial sinuses, i. 298
of kidney from tumor, v. 352
of mesentery, iv. 328
Thrush of œsophagus, iv. 59
Thumb, dislocations of, iii. 311
Thymus, diseases of, ii. 363
hyperplasia of, ii. 363
tumors of, ii. 364
Thyroglossal duct, i. 910
Thyroid, accessory, i. 910
Thyroid artery, ligation of, in treatment of goitre, ii. 389
gland accessory, ii. 313
actinomycosis of, ii. 346
alveolar tumors of, ii. 351
carcinoma of, ii. 347
of cretins, ii. 354
diseases of, ii. 297
echinococcus of, ii. 346
growths of, metastatic, ii. 346
new, ii. 347
hypertrophy of, ii. 300
inflammation of, infective, ii. 345
injuries of, ii. 344
lues, ii. 346
sarcoma of, ii. 347
syphilis of, ii. 346
tuberculosis of, ii. 345
Thyrotomy, ii. 277
Tibia, fractures of shaft of, iii. 671
tuberosities of, iii. 572
osteomyelitis of, acute, iii. 697
syphilis of, iii. 705
tuberculosis of, iii. 703
Tibial spine, tear fracture of, 582
Tibiocalcaneal resection of Bruns, iii. 886
Tibiotarsal joint, inflammation of, iii. 781
resection of, iii. 880
Toes, amputation of, iii. 880
bones of, inflammation of, iii. 783
contractures of, iii. 851
deformities of, iii. 851
inflammation of, in infectious diseases, iii. 784
injuries of, iii. 768
joints of, inflammation of, iii. 783
nails of, diseases of, iii. 775
ingrowing, iii. 776
osteomyelitis of, iii. 784
phalanges of, dislocation of, iii. 770
resection of, iii. 887
rheumatism of, iii. 784
supernumerary, iii. 722
Tongue, abscesses of, chronic, ii. 840
absence of, i. 807
actinomycosis of, i. 831
adenoma of, i. 859
angioma of, i. 840
atrophy, smooth, of roots of, i. 826
bifid, i. 807
burns of, i. 814
carcinoma of, i. 862
dermoids of, i. 852
diseases of, congenital, i. 807
endothelioma of, i. 858
fibroma of, i. 857
gumma of, i. 825
injuries of, resulting from caustics, i. 815
lipoma of, i. 856
lymphangioma of, i. 843
cavernous, i. 845
malformations of, i. 807

Tongue, papilloma of, i. 857
sarcoma of, i. 859
syphilitic papules of, i. 824
-tie, i. 808
tuberculosis of, i. 827
tumors of, i. 840
ulcerations of, in infants, i. 813
wounds of, i. 812
Tonsil, herpes of, i. 885
hypertrophy of, i. 894
pharyngeal, i. 778
inflammations of, i. 880
Tonsillitis, i. 880
Tonsillotomy, i. 896
Topography, craniocerebral, i. 333
Torsion of omentum, iv. 197
of vas deferens, spermatocele due to, v. 712
Torticollis, ii. 26
Toxic œsophagitis, iv. 61
Trachea, carcinoma of, ii. 247
fibroma of, ii. 246
fistula of, ii. 220
fracture of, ii. 155
inflammations of, specific, ii. 204
inflammatory diseases of, ii. 175
lipoma of, ii. 247
malformations of, ii. 147
new growths of, ii. 246
osteoma of, ii. 247
packing of, ii. 273
papilloma of, ii. 246
sarcoma of, ii. 247
stenosis of, ii. 218
syphilis of, ii. 207
tumors of, ii. 246
wounds of, ii. 157
Tracheocele, ii. 147
Tracheotomy, ii. 250
in gunshot wounds of face, i. 466
in peritonsillar abscess, i. 886
prophylactic, in operations on pharynx, i. 917
in resection of jaw, i. 726
Transplantation of tendons of thigh, iii. 561
Transudation of peritoneum, iv. 154
Transverse processes of vertebræ, isolated fractures of, ii. 683
Trapezius, traumatic lesions of, iii. 19
Traumatic coxitis, iii. 453
cystitis, v. 471
fistula of bladder, v. 456
spondylitis, ii. 679
uronephrosis, v. 263
Traumatisms of kidney, hemorrhage from, v. 342
of spleen, iv. 700
Trendelenburg's canula with Rosenbach's control-bulb, ii. 274
operation for radical cure of hernia, iv. 516
for varicosities, iii. 694
test for varicosities, iii. 691
prostatic scissors, v. 557
Trephining, technic of, i. 324
Trifacial nerve, injuries of, i. 237
Trigeminal nerve, resection of, i. 577
neuralgia, i. 561
Trigger finger, iii. 363
Tripier's amputation, iii. 877
Trochanteric bursitis, iii. 521
Trochlear nerve, injuries of, i. 236
Trophic disturbances of fingers, iii. 337
of foot, iii. 869
of hand, iii. 337
Tubercular perinephritic abscess, v. 320
Tuberculosis of ankle, iii. 774
of anus, v. 103
of bones of pelvis, v. 50
of breast, ii. 574
of clavicle, iii. 85
of cranial bones, i. 158
cutis of face, i. 484
of ear, i. 384
of elbow-joint, iii. 215
of epididymis, v. 699
of facial bones, i. 490
of fibula, iii. 703
of fingers, iii. 354
skin of, iii. 333
of foot, bones of, iii. 786
joints of, iii. 786
skin of, iii. 774
of hand, bones of, iii. 351
skin of, iii. 333
of hip-joint, iii. 463
of humerus, shaft of, iii. 149
of intestine, iv. 320
of joints of pelvis, v. 50
of kidney, v. 316
of knee-joint, iii. 600
of larynx, ii. 204
of lung, ii. 519
of maxillary bones, i. 676
of metacarpals, iii. 354
of metacarpophalangeal joint, iii. 356
of mouth, i. 827
of nose, i. 774
of œsophagus, iv. 63
of penis, v. 643
of pharynx, i. 898, 901
of prostate, v. 545
of rectum, v. 103
of ribs, ii. 456
of salivary glands, i. 633
of seminal vesicles, v. 719
of shoulder-joint, iii. 92
of skull, i. 158
of spine, ii. 701
of sternum, ii. 456
of subdeltoid bursa, iii. 79
of suprarenal glands, v. 417
of testicle, v. 699
of thyroid gland, ii. 345
of tibia, iii. 703
of tongue, i. 827
of ureter, v. 322
of urethra, v. 621
of wrist-joint, iii. 351

Tuberculous abscess of liver, iv. 643
of neck, ii. 84
adenitis of axilla, iii. 80
of face, i. 490
cystitis, v. 495
empyema, ii. 485
fistula in ano, v. 116
glands, differentiated from appendicitis, iv. 360
inflammations of face, i. 484
lymphoma, ii. 94
omarthritis, iii. 92
peritonitis, iv. 192
tenosynovitis of fingers, iii. 343
of hand, iii. 343
ulcers of face, i. 484
Tubular carcinoma of mammary glands, ii. 587
Tumors, abdominal, iv. 239
of alveolar process, i. 693
of anus, v. 144
in appendicitis, iv. 357
of axilla, iii. 83
benign epithelial, i. 795
of biliary passages, iv. 694
of bladder, v. 521
cystitis due to, v. 499
of bones of forearm, iii. 257
of brain, i. 317
in carcinoma of stomach, iv. 377
cavernous, associated with myeloceles, v. 20
of chest-wall, benign, ii. 461
malignant, ii. 469
of clavicle, iii. 85
of coccyx, v. 20
of cranial bones, i. 136
of ear, i. 386
of face, i. 501
of foot, iii. 870
of gall-bladder, iv. 694
of groin, iii. 557
of gums, i. 693
of hand, iii. 365
of humerus, iii. 149
of hyoid bone, ii. 39
of hypopharynx, benign, i. 909
of inguinal glands, iii. 557
region, iii. 557
of intestine, iv. 385
fecal, iv. 281
of jaw, i. 693
body of, i. 676
of kidney, v. 349
benign, v. 353
cystic, v. 366
malignant, v. 355
pelvis of, v. 349
retention, v. 258
of knee, iii. 646
-joint, iii. 648
of larynx, benign, ii. 224
malignant, ii. 233
of leg, iii. 709
of liver, iv. 643, 654
Tumors of lungs, benign, ii. 528
malignant, ii. 525
of male breast, ii. 610
of mammary gland, ii. 577
of mediastinum, ii. 536
benign, ii. 537
malignant, ii. 539
of mesentery, iv. 196
of mesopharynx, mixed, i. 908
of mouth, i. 840
cystic, i. 847
of nasopharynx, i. 784
benign, i. 788, 905
malignant, i. 795
of neck, branchiogenic, ii. 123
cystic, ii. 120
solid, ii. 130, 132
of omentum, iv. 196
of pancreas, iv. 737
of penis, v. 643
of peritoneum, iv. 196
of pharynx, i. 905
malignant, i. 811
vascular, i. 907
of pleura, malignant, ii. 500
of prostate gland, v. 562
of radius, iii. 257
of rectum, v. 144
benign, developing from connective tissue, v. 145
from epithelial portion of rectum, v. 146
malignant epithelial growths, v. 148
of renal pelvis, v. 373
retromaxillary, i. 712
retropharyngeal, i. 793, 911
sacrococcygeal, v. 30
sacrolumbar, v. 20
of sacrum, v. 20
congenital, v. 17
of salivary glands, i. 643
inflammatory, i. 631
mixed, i. 645
of scapula, iii. 85
of scrotum, v. 663
benign, v. 666
malignant, v. 666
of seminal vesicles, v. 720
of shoulder, iii. 84
of skin of upper arm, iii. 144
of soft parts of skull, i. 40
of spermatic cord, membranes of, v. 687
of spinal cord, compression, ii. 633
of spine, ii. 761
of spleen, iv. 704
of stomach, iv. 369
of suprarenal glands, v. 417
of teeth, i. 696
of testicle, benign connective tissue, v. 714
epithelial, v. 715
membranes of, v. 687

Tumors of testicle, solid, v. 712
of thigh, bones of, iii. 555
muscles of, iii. 557
nerves of, iii. 558
skin of, iii. 557
soft parts of, iii. 557
of thymus, ii. 364
of tongue, i. 840
cystic, i. 847
in ulcer of stomach, iv. 305
of ulna, iii. 257
of umbilicus, iv. 147
of ureter, v. 391
of urethra, v. 622
benign, v. 622
malignant, v. 622
Tuttle's proctoscope, v. 80
Tympanic cavity, injuries of, i. 359
Typhoid fever, ulcers of intestine from, iv. 318
ulcer, peritonitis from, iv. 180

ULCERATION of carcinoma of intestine, iv. 392
of nose, i. 773
of tongue, in infants, i. 813
Ulcers in carcinoma of stomach, iv. 376
of cranial bones, syphilitic, i. 157
of duodenum, iv. 315
of foot, perforating, iii. 867
gastric, peritonitis from, iv. 179
of intestine, iv. 317
of jejunum, iv. 317
of leg, iii. 684
of œsophagus, iv. 62
decubital, iv. 63
of penis, due to carcinoma, v. 650
of rectum, v. 98
gonorrhœal, v. 99
of stomach, iv. 300
typhoid, peritonitis from, iv. 179
Ulcus molle, v. 101
Ulna, defect of, iii. 243
diseases of, iii. 255
dislocation of, at elbow, iii. 207
at lower end of, iii. 303
fractures of coronoid process of, iii. 189
of olecranon process of, iii. 190
of shaft of, iii. 251
malformations of, iii. 243
osteomyelitis of, iii. 255
sarcoma of, iii. 257
tumors of, iii. 257
Ulnar artery, ligation of, iii. 259
at wrist, iii. 375
nerve, diseases of, iii. 145
injuries of, iii. 122, 238
neuroma of, iii. 145
plastic operations on, iii. 233
in upper arm, exposure of, iii. 156
Umbilical hernia, iv. 593
stone, iv. 146
Umbilicus, carcinoma of, iv. 149
Umbilicus, concretions of, iv. 146
cysts of, dermoid, iv. 149
sebaceous, iv. 149
epithelioma of, iv. 149
fistula of, inflammatory, iv. 146
gangrene of, iv. 146
granuloma of, iv. 147
inflammations of, iv. 146
malformations of, iv. 142
papillary fibroma of, iv. 148
sarcoma of, iv. 148
tumors of, iv. 147
Undescended testicle, v. 653
Unna's zinc-gelatin for ulcers of leg, iii. 687
Urachal fistula, v. 428
Urachus, fistula of, iv. 145
malformations of, iv. 145
Uranoplasty, technic of, i. 450
Uranoschisma, i. 443
Urates, vesical calculi composed of, v. 502
Ureteral catheterization, v. 195
cystoscope, v. 203
Ureteritis, v. 389
Ureters, absence of, v. 220
anatomical characteristics of, v. 176
blood-clots in, v. 193
catheterization of, v. 195
congenital abnormalities of, v. 221
cystic dilatation of, v. 227
cysts of, v. 391
development of, v. 222
diseases of, v. 389
double, v. 225
examination of, v. 186
fistula of, v. 378
impacted calculi of, v. 387
implantation of, v. 384
incision of, for calculi of kidney, v. 315
inflammations of, v. 389
injuries of, v. 375
openings of, abnormal, v. 225
operations on, v. 393
relations of, v. 175
removal of, for tuberculosis, v. 332
resection of, v. 383
suture of, v. 381
transplanted in rectum, v. 443
tuberculosis of, v. 322
tumors of, v. 391
Urethra, absence of, v. 570
calculi in, v. 619
of bladder and, v. 506
carcinoma of, v. 622
cauterization of, v. 610
congenital malformations of, v. 569
constrictions of, v. 570
dilatation of, v. 570
diseases of, exclusive of venereal diseases, v. 621
diverticulum of, v. 572
double, v. 570
examination of, v. 565
fistulas of, v. 614

Urethra, foreign bodies in, v. 616
injuries of, v. 589
lacerations of, v. 589
obliteration of, v. 570
papilloma of, v. 622
partial closure of, v. 570
polyps of, v. 622
rupture of, v. 589
strictures of, v. 599
congenital, v. 571
suture of, v. 598
tuberculosis of, v. 621
tumors of, v. 622
benign, v. 622
malignant, v. 622
Urethral endoscope, v. 565
fever, v. 568
openings, abnormal, v. 225
specula, Simon's, v. 426
speculum, v. 195
Urethrometer, v. 604
and dilator, v. 604
Urethrotomes, Fessenden-Otis, v. 611
Kollmann's, v. 611
Thompson's, v. 611
Urethrotomy, v. 597
external, v. 611
internal, v. 610
Uric acid, vesical calculi composed of, v. 502
Urinary fistulas, following injuries of bladder, v. 456
infiltration, causing peritonitis, v. 452
in rupture of urethra, v. 592
Urine in calculi of bladder, v. 506
of kidney, v. 299
in cystitis, v. 477
examination of, in renal diseases, v. 193
in hypertrophy of prostate, v. 555
residual, v. 548
sediments in cystitis, v. 480
segregator, Cathelin's, v. 209
Harris', v. 201
Luy's, v. 208
Morris', v. 200
Rose's, v. 199
in tuberculosis of kidney, v. 325
in uronephrosis, v. 272
Uronephrosis, v. 261
hemorrhage in, v. 341
traumatic, v. 263

VAGINAL cystocele, v. 469
Vagus nerve, injuries of, ii. 62
Valvular formation after gastro-enterostomy, iv. 438
Varicocele, v. 687
clamp, v. 690
compressor, v. 690
resection of scrotum for, v. 691
Varicose veins of leg, iii. 690
of thigh, iii. 550
Varix of œsophagus, iv. 108
of pharynx, i. 908
Vas deferens, removal of, for hypertrophy of prostate, v. 560
torsion of, spermatocele due to, v. 712
Vascular space, abscesses of, ii. 83
inflammation of, ii. 83
tumors of neck, ii. 130
Vasectomy, v. 560
Veins, femoral, injuries of, iii. 532
of neck, injuries of, ii. 55
ligation of, ii. 59
portal, obstruction of, iv. 330
saphenous, ligation of, iii. 694
subclavian, ligation of, iii. 104
varicose, of leg, iii. 690
of thigh, iii. 550
Velpeau dressing, iii. 29
Venesection, neuralgia of, iii. 124
Ventral hernia, iv. 609
Ventricular puncture, i. 204
Vertebræ, acute osteomyelitis of, ii. 697
arches of, isolated fractures of, ii. 683
caries of, compression of spinal cord in, ii. 632
complete dislocation of, with fracture, ii. 684
contusions of, ii. 672
fractures of, due to compression, ii. 681
isolated, ii. 672
injuries of, ii. 664
lateral joints of, dislocations of, isolated, ii. 664
unilateral, ii. 667
distortions of, ii. 664
spinous processes of, fractures of, isolated, ii. 683
transverse processes of, fractures of, isolated, ii. 683
vertebral articulation, distortion of, ii. 665
Vertebral artery, injuries of, ii. 43
ligation of, ii. 51
column, malformation of, ii. 652
Vesical calculi, v. 499
cystophotographs of, v. 510
facetted, v. 505
growths, forceps for removing, v. 533
hernia, v. 464
irritation due to calculi of kidney, v. 303
prolapse, v. 464
Vessels of arm, upper, injuries of, iii. 121
of elbow, diseases of, iii. 234
and forearm, diseases of, iii. 234
injuries of, iii. 234
injuries of, iii. 234
of kidney, ligation of, v. 400
popliteal, injuries of, iii. 520
sheaths of, malignant tumors of, ii. 137
of shoulder, injuries of, iii. 20
of thigh, diseases of, iii. 549
injuries of, iii. 532

Virga palmata, v. 583
Vitello-intestinal duct, cyst of, iv. 144
diverticulum of, iv. 144
faulty closure of, iv. 142
fistula of, iv. 144
Vogt's resection of ankle-joint, iii. 883
Volkmann's apparatus for talipes calcaneus, iii. 849
splint for leg, iii. 677
Volvulus, sigmoid, of intestine, iv. 341
Vulpius' aluminum splint for arm, iii. 131
for leg, iii. 676

WARTS of ear, i. 390
of foot, iii. 871
of hand, iii. 367
Weiss' rectal specula, v. 81
Welander's treatment of inguinal adenitis, iii. 523
Wharton's duct, calculi of, i. 622
cysts of, i. 639
Whitmann's brace for metatarsalgia, iii. 861
shoe brace, iii. 884
Wille's bone suture, iii. 136
Wing-skin, iii. 229
Witzel's anterior tarsectomy, iii. 887
method of establishing gastric fistula, iv. 417
operation for radical cure of hernia, iv. 516
Wladimidoff-Mikulicz' osleoplastic resection, iii. 886
Wood's operation for exstrophy of bladder, v. 432
Wounds of abdomen, punctured, iv. 125
of abdominal wall, iv. 125, 156
of arm, upper, severe lacerated, iii. 141
of bladder, perforating, v. 455
of brain, i. 245
contused, i. 246
gunshot, i. 246
infected, i. 269
lacerated, i. 249
punctured, i. 248
of chest-wall, ii. 378
simple penetrating, ii. 378
of elbow-joint, gunshot, iii. 197
of face, i. 460
gunshot, i. 464
incised, i. 461
punctured, i. 463
of fingers, iii. 314
of gluteal artery, stab-, v. 39
of hands, iii. 314
Wounds of hip-joint, gunshot, iii. 314
of intestine, iv. 263
of kidney, gunshot, v. 242
incised, v. 241
stab-, v. 241
of knee, iii. 568
of larynx, ii. 157
of liver, iv. 633
of mouth, i. 810
of muscles of upper arm, iii. 118
of pancreas, iv. 718
of pelvis, v. 39
gunshot, v. 40
stab-, v. 39
of penis, v. 634
bullet, v. 636
incised, v. 634
punctured, v. 634
of perineum, v. 40
of peritoneum, iv. 156
of pinna, i. 347
of scrotum, v. 661
of shoulder-joint, iii. 46
of skull, i. 107
of spinal cord, ii. 629
of spine, ii. 694
of stomach, iv. 263
of testicle, v. 694
of thigh, gunshot, iii. 546
of tongue, i. 812
of trachea, ii. 157
Wrist, contusions of, iii. 279
dislocation of, iii. 301
ganglion of, iii. 365
injuries of, iii. 304
-joint, tuberculosis of, iii. 351
ligation of radial artery at, iii. 375
of ulnar artery at, iii. 375
operations on, iii. 374
sprains of, iii. 279
Wry-neck, ii. 26

X-RAY in brain injuries, i. 264
for bullets in brain, i. 126
in demonstration of calculi of kidney, v. 306
in detection of foreign bodies in intestine, iv. 239
in fracture of malar bone, i. 473
in gunshot-wounds of face, i. 464

Y-FRACTURE of condyles of humerus, iii. 177

ZINC-GELATIN, Unnas', iii. 689
Zucker's pressure diverticula of œsophagus, iv. 94

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